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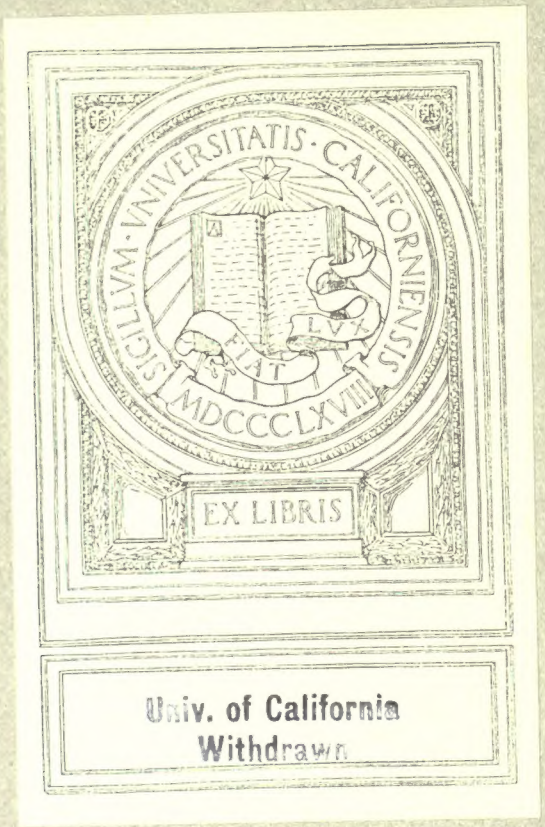

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THE

GEOLOGY

OF

PENNSYLVANIA

A GOVERNMENT SURVEY

WITH A GENERAL VIEW OF THE

GEOLOGY OF THE UNITED STATES

ESSAYS ON THE COAL-FORMATION AND ITS FOSSILS, AND A DESCRIPTION OF THE COAL-FIELDS OF NORTH AMERICA AND GREAT BRITAIN

BY

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TABLE OF CONTENTS.

BOOK VIII.

EIGHTH PALÆOZOIC DISTRICT, OR ANTHRACITE COAL-BASINS, AND ENCIRCLING BELTS OF THE OLDER CARBONIFEROUS ROCKS.

INTRODUCTION.

PAGE

Position of the anthracite basins in the mountain-chain; limits and subdivisions of the district; strata, and their relations to the topography; classification of the Coal-measures, ... 1
General structure of the mountain-chain in its relations to the anthracite basins, ... 1
General limits of the anthracite district, . . . 4
Natural leading subdivisions of the district, . 5
Description of the strata, ... 7
Vespertine series around the anthracite basins, . 8
Umbral red shale around the anthracite basins, . 9
Geographical range of the Vespertine sandstone and Umbral red shale, ... 11
General view of the Seral series or coal strata of the State, ... 13
Composition of the coal strata, ... 13
Area and general distribution of the coal strata, . 14
Limits of the Bituminous Coal-measures, . . 15
Classification of the coal-rocks, and their modifications of type, ... 16
1. The Seral conglomerate, ... 16
2. Lower Coal-measures, ... 17
3. Older coal-shales, or Lower Barren Group, . 19
4. Upper or newer Coal-measures, ... 19
5. Upper or newer coal-shales, or Upper Barren Group, 20
Anthracitic coal strata, ... 20
1. Boundaries of the several coal-basins, . . 20
2. Composition of the Seral conglomerate in the special type which it presents in the anthracite region, . 21

DIVISION I.

DETAILED DESCRIPTION OF THE SOUTHERN OR SCHUYLKILL BASIN.

CHAPTER I.

General structure and topography, ... 26
1. The Lehigh and Little Schuylkill District, . 26
2. The Schuylkill and Swatara District, . . 26
3. The Mine Hill Basin or District, . . . 27
4. The Wiconisco Basin, ... 27
5. The Dauphin Basin, ... 27
Undulations of the strata in the Southern Coal-field, . 28
Classification and brief description of the anticlinal flexures or saddles, ... 28
Anticlinals from Mauch Chunk to Patterson and Mine Hill, ... 29
Anticlinals from Patterson and end of Mine Hill or Big Creek to East Norwegian Creek, . . 31
PAGE
Main group between Tuscarora and Mill Creek, . 34
Anticlinals and basins between Mill Creek and West Norwegian, ... 38
Western series of flexures, ... 41

CHAPTER II.

First or Nesquehoning and Panther Creek division of the district between the Lehigh and Tuscarora, . 47
Eastern end of the coal-field; estates of the Lehigh and Little Schuylkill Coal Companies, . . . 48
Beginning of the coal strata, ... 48
Anticlinal axis A, or Rhume Run anticlinal, . 50
A, Panther Creek south anticlinal, or subordinate axis of Panther Creek, ... 51
B, Summit Hill and Tamaqua anticlinal, . . 52
Synclinal belts or basins, ... 53
Basin A, or synclinal trough of anticlinal A and Locust Mountain, ... 53
Nesquehoning Mines, ... 54
Coal-seams of the Nesquehoning Mines, . . 57
Basins of Panther Creek Valley opposite Summit Hill, or basins *A*, *A A*, and *B*, ... 62
Locust Mountain basin *A*, ... 62
Basin *A a* (basin of the bed of Panther Creek), . 62
Basin *B*, ... 63
Basin *B C*, or basin of the Lehigh Summit Mines, . 63
Summit Mines of the Lehigh Company, basin *B C*, 63
Coals of Panther Creek basin and saddles, . . 67
Basin *D*, or basin of Sharp Mountain and anticlinal axis C, ... 68
The Coal-measures, under the several local types they present between the Lehigh and Little Schuylkill, 69
Of the positions in the general basin of the several groups and the more important individual coal-beds, 71
Coals of Summit Hill Basin, *B*, *C*, ... 71
Arrangements of the Lehigh Company for conveying the coal of Panther Creek and the Summit Mines to market, ... 71
Coal-schutes at Mauch Chunk, ... 73
The Mount Pisgah inclined plane, ... 74

CHAPTER III.

TAMAQUA.

Coals and Coal-measures, ... 76
Individual coal-seams, ... 77
Coals on the north side of the basin at the foot of Locust Mountain, ... 78
Synclinal axis of basin *B*, ... 80
Anticlinal axis B, ... 80
Synclinal axis of basin *D*, ... 80
Greenwood Tunnel, ... 83

CHAPTER IV.

THE SCHUYLKILL OR CENTRAL DISTRICT OF THE COAL-FIELD.

PAGE
Introductory description, ... 84
Anticlinals and basins between Tuscarora and East Norwegian, ... 85
Anticlinal D, or axis of South Mine Hill, . . 85
Coal-beds lifted by this axis, ... 86
Anticlinal E, or Casca William, Diamond and Northern St Clair axis, ... 87
Of the basin *C D*, or that between the Main Mine Hill and the South Mine Hill, ... 87
Basin of anticlinals D and E, ... 88
Anticlinal F, the Patterson and St Clair axis, . 88
Coals lifted by axis *F*, ... 89
The *D F* and *E F* basin, or that of Patterson and St Clair, ... 89
Subordinate anticlinals D and D D, ... 90
Axis G—anticlinal of the Silver Creek Switch-back Railroad and of South St Clair, ... 90
Basin *F G*, ... 91
Anticlinal H—that of Sillimanville and Mill Creek Furnace, ... 91
Coals lifted by axis H, ... 92
Basin *H F* and *H G*, ... 92
Peach Mountain synclinal belt, ... 92
Peach Mountain anticlinals, ... 93
Anticlinal I, or main axis of Peach Mountain, . 95
Anticlinal I, or southern subordinate saddle of Peach Mountain axis, ... 96

CHAPTER V.

Southern coal-field between Tamaqua and Silver Creek, its anticlinals, basins, and collieries, . . 96
Anticlinal axis C, ... 96
Basin *D*.—Of the coal-beds, ... 97
Second and third Tamaqua anticlinals and related basins, 97
Axis B, ... 97
Axis B, ... 98
Basin *B*, Reinhardt's Run, Newkirk Tunnel, . . 98
Newkirk Tunnel, ... 98
Coals.—At Newkirk, ... 100
Collieries, ... 101
Coals contained in basin C, on that of the Buckville and Palmer Tunnels, ... 102
Buckville, ... 102
Coals, ... 102
Palmer Tunnel, ... 103
Tucker's Slope, basin *C*, ... 103
Coals, ... 103
Basin *C D*, or that of Tuscarora, ... 104
Slopes, ... 104
Whitfield Tunnels, De Long Tract, ... 105
Of the flexures anticlinal and synclinal in the vicinity of Tuscarora, and the coals there developed, . 105
Axis C, near Tuscarora, ... 105
Basin *C*, ... 106
Axis C and C C near Tuscarora, ... 107
Anticlinal C C C of Tuscarora, probably axis D, or that of the south ridge of Mine Hill, ... 107
The Short Saddle D, ... 108
Carter's Slope, ... 108
Casca William, ... 108
Axis of Sinnickson's Slope, or Anticlinal D, . 108
Coals in basin *D F*, on Casca William Creek, . 109
Basin *D F*, from Sharp Mountain to Silver Creek, or Patterson Basin, ... 109
Collieries and Coals—Sharp Mountain Colliery, . 110
Beachem's Tunnels, ... 110
Bushy Valley, ... 111
Meyer's Tunnels on Bushy, ... 112
The Luther or South Diamond Coal, . . . 112
Basin *F H*, or that north of the Peach Mountain Basin, from Sharp Mountain to Silver Creek, . . 112
Basin *H I*, or Peach Mountain Basin—Sharp Mountain south of Patterson, ... 113
Milford Colliery, Peach Mountain Basin, Tunnel and Slope, ... 113
Peach Mountain Basin traced from Bushy Valley westward, ... 114
Middleport Synclinal Belt, ... 114
Coals of the spurs east and south of the town, . 115
Shaftings and Tunnel south-east of Middleport, . 115
General Beckel's Tunnel, ... 115
Neville's Mine, south-east of Middleport, . . 115
Steinberger's Mines, half a mile south-west of Middleport, ... 116
Coals at Middleport, ... 116
Colahan's Gate Vein Colliery, . . . 116
Section south of the Big Gate Coal, . . . 117
New Philadelphia, ... 118
Preston's Colliery (Neville and A. Lawton's), opposite New Philadelphia, ... 118
Lick Run, ... 118

CHAPTER VI.

Coal-field between Silver Creek and Mill Creek, anticlinals, basins, and collieries, ... 119
Flexures on Silver Creek, ... 119
Coals on Silver Creek, ... 120
Anticlinal axes traced, ... 122
Coal-seams above water-level in the several basins between Silver Creek and Mill Creek, . . . 123
Details of the several collieries between Silver Creek and Mill Creek, ... 125
Novelty Colliery, ... 125
Cwmbola, Hubleyville, ... 125
Cwmbola Colliery, ... 125
Havener's (formerly), now Colahan's, . . . 126
Pinkerton's Tunnels, Bare Ridge, ... 126
Oliver's Colliery, south side of Bare Ridge, . . 127
Zachariah's Run, ... 127
Eagle Hill Colliery, Zachariah's Run, . . . 129
Belmont (Five Points), ... 129
Lewis and Spohn Coal of Belmont, . . . 129
Belmont Slope, ... 129
Ravensdale Tunnel, ... 130
Crow Hollow, ... 131
Mill Creek (above St Clair), ... 132
Structure east of Johns' Colliery, ... 132
Johns' New Slope, ... 132
St Clair Mill Creek, ... 132
Milnes and Snyder's New Slope, ... 132
McGinnis's New Slope north-east of St Clair (Carey's property), ... 133
Carey's Shaft, ... 133
Boring in Crow Hollow in basin *F G*, on the estate of the North American Coal Company, . . . 133

PAGE
Mill Creek, south of Carey's Shaft, ... 134
Upper red-ash coals of Mill Creek, ... 135
Singley's Farm, ... 137
Mill Creek (southern part) Collieries, . . . 138
Port Carbon, Mill Creek, ... 139
Coal-seams in the Gate Ridge anticlinal flexure, . 139

CHAPTER VII.

Coal-field between Mill Creek and the West Norwegian Valleys, ... 141
Anticlinal and synclinal flexures, and the coal-beds contained in each basin, ... 141
Basin *D E* west, or that of Mount Laffy, . . 141
Belt E G, ... 141
Belt G H, ... 142
Peach Mountain Basin, ... 142
Basin *i J*, ... 143
Basin *J K*, or that of West Norwegian, . . 143
Basin *K*, or that of the Schuylkill at Pottsville, . 144
Details of the several collieries and mining localities from Mill Creek to West Norwegian, . . . 145
Section on East Norwegian, ... 145
Middle Norwegian, ... 146
North American Company's Mines, . . . 146
West Norwegian, ... 147
Brown's Colliery, ... 147
Peach Mountain Coal of West Norwegian (Delaware Mines), ... 148
Sharp Mountain Coal-measures, Pottsville, . . 149
Coals in the north side of the Sharp Mountain Basin, 151
Salem Colliery, Salem Hollow, east of Pottsville, . 151

CHAPTER VIII.

Anticlinal flexures of the coal-field between West Norwegian and Swatara valleys traced in detail, with the coal-beds along their axes, ... 152
Axis of Swatara Falls and Primrose Hill, or anticlinal M, ... 152
Axis of the Dripping Arch and Phœnix Mines, or anticlinal N, ... 154
Basin *M N*, south of Swatara Falls axis—part of Fisher's Basin, ... 155
Western Group of the subordinate anticlinals of the centre of the coal-field, between West Branch and Swatara, ... 157
Peach Mountain Kantner axis, or anticlinal N, . 157
Minersville central axis, or anticlinal O, . . 158
Minersville South or Peach Mountain inverting axis, or anticlinal O, ... 159
Axis of West-West Branch, or anticlinal P, . 160
Griscom's axis, or anticlinal P, ... 161
Llewellyn north axis, or anticlinal QQ, . . 161
Branchdale Lewis Vein axis, or anticlinal P west, 162
Llewellyn middle axis, or anticlinal Q, . . 162
Axis of Big Lick Mountain, or anticlinal Q, . 163
Axis of Little Lick Mountain, or anticlinal R, . 164
Axis of Red Mountain, or Gate Ridge on anticlinal S, 166

CHAPTER IX.

Collieries between the West Norwegian and the Swatara, 168
Mine Hill Gap Colliery (John Doherty's), . . 168
Dundas Colliery, No. 1 (about 400 yards west of Doherty's) 168
PAGE
Minersville—basin *O o*, ... 169
West Branch, ... 169
Coals on the S. side of Mine Hill Gap—Basin *C E* west, ... 169
Section of the Coal-measures in Sharp Mountain at the West Branch Gap, ... 170
Collieries—Wolf Creek, ... 171
Anticlinal flexures and their coals on West-West Branch, ... 172
Griscom's Axis and Mines, ... 172
Red Mountain axis, ... 173
Miller and Stahl's Phœnix Colliery, . . . 174
Llewellyn, ... 175
Salem Colliery, below Llewellyn, ... 175
Branchdale Colliery (McDonald's), Muddy Branch, 176
Lower or Little Muddy Branch, Red Mountain axis, ... 177
Bettinger's Mines, Little Muddy Creek, . . 177
Coals on Swatara, ... 177
Swatara Colliery (D. P. Brown & Co.), . . 178
Middle Creek, ... 178

CHAPTER X.

Coal-field between Middle Creek and the forking of the basin, ... 179
Basin of Donaldson, or basin *N Q*, . . . 180
Thick Mountain Tunnel and Drifts, . . . 181
Basin of Big and Little Lick Mountains, or basin *Q R*; also Little Lick Mountain, ... 181
Big Lick Mountain anticlinal, ... 182
Coals in the gap of Big Lick Mountain, Donaldson, 182
Little Lick Mountain, ... 183
Basin of Little Lick Mountain and Red Mountain, 184
Basin of Red Mountain anticlinal axis and Sharp Mountain, ... 185
Red Mountain or Gate Range, ... 185
Sharp Mountain Coals, their number and unusual position, ... 186

CHAPTER XI.

Wiconisco and Dauphin Basins, or the western branch basins of the Southern Coal-field, . . . 188
Wiconisco, or Bear Valley Coal-basin, . . . 189
Klinger's Gap coal strata, ... 189
Bear Gap, ... 191
The Dauphin Basin, ... 193
Black Spring Gap, ... 195
The Rausch Gap Section, ... 195
Yellow Spring Gap Section, ... 196
Rattling Run Gap, ... 197
Big Flats, ... 198

CHAPTER XII.

Mine Hill Basin, and Mine Hill, ... 198
Structure of Mine Hill, ... 199
Western Mine Hill, ... 200
Mine Hill Basin, its Structure, Coal-seams, and Collieries, ... 201
Collieries and Coals of Mine Hill Valley, . . 202
Lawton's Old Colliery Gap, ... 202
Big Coal of Kelly's Hollow, ... 203
Mine Hill Valley, from Mine Hill Gap westward, . 204
Pine Knot Colliery, ... 204

PAGE

Lewis Dougherty's Colliery, east side of Mine Hill Gap, ... 205
Charles Hill's Colliery, west of Mine Hill Gap. . 205
McGinnis's Hollow, ... 205
Coals at McGinnis's, ... 206
Dyer's Run, Sando's Colliery, about one mile west of McGinnis's, ... 206
Heckscherville Slope and Tunnel, ... 207
Thomastown Tunnel, ... 207
Oliver's Colliery, Peaked Mountain, . . . 208
Meckesburg—Mecke's Western Tunnel, . . . 208
Glen Carbon—Staunton's Tunnel—Dundas Tract, 208
Rohrersville—Rohrer's Mines, ... 209
Peaked Mountain and Buck Ridge anticlinal, and limit of Coal in Buck Ridge Basins north and south, . 209
Buck Ridge and Peaked Mountain anticlinal, . 210
Of the south-western branch of Mine Hill Basin, . 211

CHAPTER XIII.

Description of the more important Coal-seams of the southern Coal-field, with the duplicate names which many of them bear, ... 212
Description of the several coals, ... 213
Synonyms of the coals having more than one name in the Pottsville Basin, ... 221
The Norwegian Valleys, ... 223
West Branch and Wolf Creek, ... 223
West-West Branch, ... 224
Mine Hill Valley, ... 224
Muddy Branch, ... 224

CHAPTER XIV.

Small coal-basins of Broad Mountain, . . . 225
Broad Mountain, Mill Creek Basin, ... 225
Broad Mountain, Rattling Run Basin, . . . 226

CHAPTER XV.

General classification of the Coal-measures of the Pottsville Basin, ... 226
Coal-measures on Little Schuylkill, . . . 227
Coal-measures on Silver Creek, ... 227
Coal-measures on Mill Creek, ... 229
Coal-measures on West Branch and Wolf Creek, . 230
Coal-measures in the Thick Mountain north of Donaldson, ... 231
Relation of the coal-beds of Mine Hill Valley to the White-ash Groups of the Main Pottsville Basin, 232

CHAPTER XVI.

Faults and slips of the strata, ... 234
Contortions, faults, and troubles, ... 235

DIVISION II.

EASTERN MIDDLE ANTHRACITE COAL-FIELD.

CHAPTER I.

General structure and topography, ... 239
Anticlinal belt No. 1, or that of Pismire Ridge, . 239
Coal-basin No. 1, or that of Beaver Meadow, . 240
Anticlinal belt No. 2, or that of Catawissa Ridge, 240
Coal-basin No. 2, ... 240
Anticlinal No. 3, or that of Council Ridge and Little Tomhicken Valley, ... 241
Coal-basin No. 3, or that of Hazleton, . . . 241
Anticlinal No. 4, or that of East Buck Mountain, Black Creek Ridge, and Racoon Valley, . 242
Coal-basin No. 4, or that of Big Black Creek, . 242
Anticlinal No. 5, or that of Conyngham Valley, . 242
Coal-basin No. 5, or that of Little Black Creek and Main Black Creek, ... 243
Coal-basin No. 6, or that of East Green Mountain, 243
Coal-basin No. 7, or that of McCauley's Mountain, 243
Sugar-loaf Knob, ... 243

CHAPTER II.

The Beaver Meadow, or southern basin of the East Middle Coal-fields, or Coal-basin No. 1, . 244
Anticlinal undulations of the Beaver Meadow Coal-field, ... 244
Eastern anticlinals of the Coal-field, . . . 244
Anticlinal axis B, ... 245
Sub-basin A, or that of axes A B, . . . 245
Anticlinal axis C, ... 245
Basin *b*, ... 246
Anticlinal axis D, ... 246
Basins of axes A to D, and of D, and of Main Axis No. 1, ... 246
Western anticlinals of the Beaver Meadow Coal-field, 246
Coal-measures on axis E, ... 247
Basin *c*, or that of South Beaver Creek, . . 248
Anticlinal axis F, or that of Jeanesville, . . 248
Basin C, or that of the York Company, and the Jeanesville South Slope Mine, ... 248
Extent of the Big Coal in the Middle Basin, . 249
Jeanesville Slopes, ... 249
Jeanesville, ... 250
North Beaver Meadow Basin, or basin *g*, . . 251
Limits of the Big Coal in the North Beaver Meadow Basin, ... 251
Dreck Creek Coal-basin, or basin No. 2, . . 251

CHAPTER III.

The Hazleton Basin and its branches, or basin No. 3, 252
Anticlinals H and J, ... 252
Basin *h*, or No. 1 of the Buck Mountain Company's Lands, ... 252
Basin *i*, or No. 2 of the Buck Mountain Company, 253
Coal of the Buck Mountain Company's basins, . 253
Basin *j*, or that of the Board Yard, . . . 254
Basin *k*, ... 254
Anticlinal M, or that of Crystal Ridge, . . 254
Anticlinal N, or that of Cranberry Ridge, . . 254
Anticlinal O, or that of Tomhicken Ridge, . . 255
Basin N, or that of Big Tomhicken, . . . 255
Basin O, or North Branch of the Hazleton Basin, . 255
The Main Hazleton Coal-basin, ... 256
Hazleton, ... 257
Limits of the Main Coal-seam, and the collieries at present established on it in the Hazleton Basin, 259

CHAPTER IV.

Black Creek Basins, ... 260
Big Black Creek Basin, or basin No. 4, . . 260
Anticlinals P and Q, and basins *p*, *q*, and *r*, . 261

PAGE
Anticlinals R, S, and T, and basins *s* and *t*, . . 261
Big Black Creek Basin, ... 261
Basin No. 5.—Little Black Creek Basin, . . 262
Basin of Main Black Creek, or basin No. 5 west, . 263
East Green Mountain basins, No. 6, . . 263
Basin No. 6, *y*, ... 264
Basin No. 7, or that of McCauley Mountain, . 264

DIVISION III.

WESTERN MIDDLE COAL-FIELD.

CHAPTER I.

MAHANOY COAL-REGION.

General structure and topography, . . . 265
Mahanoy and Shamokin coal region, . . . 266
Detailed description of the anticlinal and synclinal flexures, ... 266
Anticlinal of Head and Big Mountain, No. 1, . 267
Coal-basins of Head and Big Mountain, Nos. 1 and 2, 267
Bear Ridge anticlinal, and the south basin of the Mahanoy south of it, ... 268
Coal-measures in Bear Ridge, . . . 269
Basin No. 3—the Mahanoy Basin proper, or the South Mahanoy Basin, ... 270
Axis No. 4—Shenandoah axis, . . . 271
Basin No. 4, ... 271
Anticlinal axis No. 5, or that of Ashland, . 272
Basins between the Mahanoy and Locust mountains, 272
Basin No. 5, or Ashland Basin south of anticlinal No. 5, ... 272
Basin No. 6, or that of the south side of Locust Mountain, ... 273
Coal-beds in the coal-field between the Mahanoy and Locust mountains, ... 274
Mahanoy Gap, ... 274
Flexures and coals on Big Mine Run, . . 276
Flexures and coals on Little Mine Run, . . 276
Flexures and coals on Locust Run, and on the Catawissa Road, ... 277
Anticlinal flexures and intervening basins of the Shamokin Coal-field, with the coals which they present, 277
Anticlinal No. 6—that of Locust Mountain, . 277
Strata elevated to the surface by this anticlinal, . 278
Anticlinal No. 7—that of Mine Ridge and of Mount Carmel, ... 278
Strata exposed by denudation along this anticlinal, 279
Synclinal valley or basin No. 7, being that between the Locust Mountain and Mount Carmel anticlinals, 280
Subordinate anticlinal flexures in the Mount Carmel Basin, ... 281
Of the several subordinate basins embraced in basin No. 7, or that of Mount Carmel, and of the coals contained in them, ... 283
Of the narrow troughs in basin No. 7, west of Green Ridge Gap, ... 285
Shamokin Basin, ... 285
Coal Run Improvement and Railroad Company, . 285
Locust Mountain Coal and Iron Company, . 286
The Coal Mountain Coal Company, . . 286
Green Ridge Coal Company, . . . 286
Anticlinal No. 8, or that of Red Ridge, . . 287
Coal-measures exposed by denudation along anticlinal No. 8, or that of Red Ridge, . . . 288
Of the Coal-measures exposed along axis A of basin 8, or that of Jamie's or Green Ridge, . . 289
Of the subordinate basins included in basin 8, . 291
Anticlinal No. 9, or that of Coal Run Ridge, . 292
Coal-measures exposed along the Coal Ridge anticlinal, 293
Basin No. 9, or that of the north branch of Shamokin, 293
Of the Coal-measures preserved in different parts of basin No. 9, ... 294
Anticlinals in the prolongation of Basin 9, south of Shamokin, ... 295
Basin No. 10, or that of Coal Run and its included anticlinals, ... 297
Description of the Coal-measures in Coal Run Basin and at Shamokin Gap, ... 299
Estimate of the coals in Coal Run Basin, . . 301

CHAPTER II.

Structure and contents of the coal-field between Shamokin Gap and the western extremity of the basin, 306
Coal-beds on the Scott and Hunter tracts south of Carbon Run, ... 307
Western end of the basin, or that watered by the east and west branches of Zerbe's Run, . . 308
Coal-seams in the Zerbe's Run, or Trevorton District of the Shamokin Coal-field, ... 309
Description of the individual coal-seams in the ascending order, ... 311

DIVISION IV.

NORTHERN ANTHRACITE COAL-FIELD, OR BASIN OF THE LACKAWANNA AND NORTH BRANCH OF THE SUSQUEHANNA.

CHAPTER I.

Topographical features, composition of the strata, and general structure of the basin, . . . 318
Form and interior features of the valley, . . 318
General view of the strata, ... 319
General structure of the basin, . . . 323
Undulations of the basin, ... 324
The Coal-measures, ... 328
Subdivisions of the coal-field, . . . 329

CHAPTER II.

Carbondale and Archbald district, . . . 330
Valley north-east of Carbondale, . . . 330
Of the Lackawanna Basin, from Carbondale southward, ... 331
Archbald, ... 334
Jessup, ... 335

CHAPTER III.

Coal-measures of the Scranton District of the Lackawanna Basin, ... 338
The individual coal-beds, and the strata which separate them, ... 338
Undulations of the strata in the Scranton District of the Lackawanna Coal-basin, and the distribution of the several Coal-seams in their local basins, . . 342
Positions and distribution of the several coal-seams, 345
Coals in the basin south of axis No. 2, . . 345
Coal B, Roaring Brook Basin, . . . 346

PAGE
Coal D, Roaring Brook Basin, ... 347
Coal E, Roaring Brook Basin, ... 347
Coal F, Roaring Brook Basin, ... 347
Of the Roaring Brook Basin west of the Lackawanna, 348
Coals in the Scranton Basin, or that between axis No. 2 and axis No. 4, ... 351
Basin of Pine Brook and the Lackawanna, . 352
Basin of the Diamond Mines, ... 352
Road between Hyde Park and Pittston, . . 355
From Spring Brook towards Scranton *via* the south road, ... 356
Strata exposed on the Pennsylvania Company's Loaded Track railroad from Pittston towards Scranton, 357
Iron ores of the vicinity of Scranton, . . 357
Iron ores of the Coal-measures, . . . 358
Other iron ores smelted at Scranton, . . 359
Roaring Brook Falls, ... 360
Absence of coal in Spring Brook Valley, south of the Loaded Track, ... 360

CHAPTER IV.

THE PITTSTON AND MILL CREEK DISTRICT.

General section of the Pittston and Port-Griffith Coal-measures, ... 361
Axis VI., or that of Morgan's Mine, . . 361
Strata lifted by axis VII., ... 362
Axis VIII., or that of the Iron Foundry, . . 362
Axis IX., ... 363
Strata lifted to the surface by axis IX., . . 364
Axis X., or that of Plainville, . . . 365
Basin X., or that north of axis X., . . . 366
Axis XI., ... 367
Axis XII., or that of Bennett's Big Coal, . . 367
Axis XIII., ... 368
Axis XIV., or that of Miner's Mill, . . 369
Axis XV., or that south of Gardiner's Creek, . 369
Axis XVI., or that of the New Haven Mine, . 370
Works of the Pennsylvania Coal Company at Pittston, 371
New mines of the Pennsylvania Coal Company, . 373
Port Griffith, ... 373
Coal-mines traced from Wilcox's north-east towards Pittston, ... 374
Plainsville, ... 375

CHAPTER V.

Wilkesbarre, Nanticoke, and Shickshinny district, . 376
Synclinal belt or general basin XVII., . . 376
Position of the main synclinal axis of the river-basin, 379
Coal-measures contained in the river-basin west of Wilkesbarre, ... 380
Anticlinal belt XVII., ... 381
The Great Baltimore Bed, ... 381
Basin XVIII. and its undulations, . . . 384
Anticlinals included in basin 18, . . . 385
Anticlinal range XIX., ... 389
Basin 19, or that of the north foot of the Little Mountain, ... 390
Distribution of the coal in the east end of basin 19, 393
Coals in Solomon's Gap, ... 394
District west of Solomon's Gap, ... 395
Iron ores, Lee's Mines, Nanticoke, . . . 399
From Nanticoke westward, ... 399
PAGE
The Hog-back, ... 401
Coal-basin west of the Susquehanna, . . 404
Iron ores, ... 404

CHAPTER VI.

Wyoming, Kingston, and Plymouth District, . 405
Monoclinal south-dipping belt of strata between the Pittston Gap and Hertzoff's Hollow, . . 405
Of the coal-beds hitherto discovered in this belt, . 406
Iron ores, ... 407
The Plymouth Belt, or that extending from Kingston to Nanticoke Notch, ... 407
Coal-measures and workable coal-seams of the Plymouth District, ... 409
1st, The Plymouth Great Bed, ... 409
2d, Bennett's or Patton's Coal-bed, . . . 410
3d, The Cooper or Orchard Bed, ... 410
4th, The Gould Coal-bed, ... 411
Outcrops of the coals, ... 412

APPENDIX TO BOOK VIII.

BEING A REVISION OF PORTIONS OF THE SOUTHERN ANTHRACITE COAL-FIELD.

Tuscarora, ... 413
Middleport, ... 414
Casca William Valley, ... 415
Silver Creek, ... 417
Zachariah's Run, ... 419
East Ravensdale, ... 419
Crow Hollow, ... 420
Mill Creek, ... 420
East Norwegian, ... 424
West Norwegian, ... 424
West Branch, ... 426
Minersville, ... 428
Wolf Creek, ... 429
West-West Branch, ... 431
Muddy Branch, ... 434
Swatara, ... 436
Middle Creek, ... 438
Donaldson, ... 438
Rausch Creek, ... 439
Bear Gap, ... 440
Mine-Hill Valley, ... 442

BOOK VIII.—(*Continued*).

Broad-Top Coal-field, ... 448
Boundaries of the Broad-Top Coal-field, . . 448
Area of coal, ... 449
North Wray's Hill, ... 449
Shoup's Run, ... 453
Six-mile Run, ... 455
Round Knob, ... 459
Sandy Run, ... 461
Kimber's Run, ... 463
Iron ores, ... 464
Areas of the coal-basins of Pennsylvania, . . 465

PAGE

BOOK IX.

NINTH PALÆOZOIC DISTRICT, OR BITUMINOUS COAL-FIELDS AND THEIR ASSOCIATED OLDER CARBONIFEROUS STRATA.

DIVISION I.

VESPERTINE AND UMBRAL SERIES IN THE BITUMINOUS COAL REGION OF PENNSYLVANIA.

Topographical relations of the Vespertine and Umbral series, ... 466

CHAPTER I.

Vespertine conglomerate—geographical distribution, 467
Modifications in the type and thickness of the Vespertine sandstone in the bituminous coal region, . 467

CHAPTER II.

Umbral red shale—geographical distribution, . 468
Modifications in the type and thickness of the Umbral red shale in the bituminous coal region, . . 469

DIVISION II.

GENERAL VIEW OF THE BITUMINOUS COAL STRATA.

INTRODUCTORY CHAPTER.

Stratigraphical arrangement of the Coal-measures of Western Pennsylvania, ... 474
A general vertical section of the bituminous coal strata of Pennsylvania, ... 474
General description of the several bituminous coal-basins, ... 477
The anticlinal axes and their intervening coal-basins, 479

SUBDIVISION I.

Bituminous coal-basins north of the Conemaugh and Ohio, 480

CHAPTER I.

First Basin and principal axis north-west of the Alleghany Mountain, ... 480

CHAPTER II.

Second Basin and axis north-west of the Alleghany Mountain, ... 482
Second coal-basin, Towanda Mountain, . . 482
Towanda Coal-field, ... 482
The Lycoming or Ralston Coal-field, . . 482

CHAPTER III.

Third Basin and anticlinal axis, . . . 483

CHAPTER IV.

The Fourth Basin and anticlinal axis, . . 485

CHAPTER V.

Fifth Basin and anticlinal axis, . . 486
Coal-beds of the Fifth Basin, . . 487

CHAPTER VI.

The Sixth Coal-basin, and final outcrop on the north-west, 488
Coal-measures of the Sixth Basin, Tionesta group, 489
Sharon Group, ... 489
Clarion Group, ... 490
The Brookville Coal, ... 490
Clarion Coal and Ferriferous Limestone, . . 490
The Scrubgrass Coal-bed, ... 491
Kittanning Coal-bed, ... 491
The Freeport Group, ... 492
The Lower Freeport Coal, ... 492
The Freeport Limestone, ... 492
Upper Freeport Coal, ... 493
The Barren Group, ... 493
The rest of the Barren measures, . . . 493

SUBDIVISION II.

Bituminous coal-basins south of the Conemaugh and Ohio, ... 493

CHAPTER I.

The First Coal-basin and its subdivisions, or the synclinal belt between the Alleghany Mountain and Laurel Hill, ... 494
The first or Salisbury subdivision, . . . 494
The second or Stoyestown subdivision, . . 495
The third or Johnstown subdivision, . . 496

CHAPTER II.

The Second Coal-basin, or Ligonier Valley, . . 497

CHAPTER III.

The Third Basin and its subdivisions, being the region west of Chestnut Ridge, and south of the Conemaugh and Ohio, ... 499
First subdivision of the Third Basin, . . 500
Lower or Clarion and Freeport Group, . . 501
Middle or Barren Group, ... 502
The Upper or Greene County Group, . . 503
The Pittsburg Coal-bed, ... 503
The Redstone Coal, ... 505
The Sewickly Coal, ... 505
The Great Limestone Bed, ... 505
The Uniontown Coal, ... 506
The Waynesburg Coal-bed, ... 506

SUBDIVISION III.

Detailed description of the bituminous coal region, . 507

CHAPTER I.

The First Basin westward to Pine Creek, . . 507

CHAPTER II.

Second Bituminous Coal-basin westward to Pine Creek, 511
Towanda Coal-basin, ... 513
Ralston, ... 513
Cartersville, ... 517
Blossburg, ... 519

PAGE

CHAPTER III.

The Third Coal-basin westward to Pine Creek, . 519

CHAPTER IV.

The Fourth Basin westward to Pine Creek, . . 524
Cowanesque, ... 525

CHAPTER V.

The Fifth Coal-basin west to the Genesee River, . 525

CHAPTER VI.

Country between Pine Creek and the Susquehanna waters, ... 526

CHAPTER VII.

First Basin traced from the Susquehanna south to Cambria County, ... 527
Taugascootac, ... 529
Philipsburg, ... 531

CHAPTER VIII.

Second Basin traced from the Susquehanna south-west into Cambria County, ... 533
Karthaus, ... 535
Clearfield Creek, ... 537

CHAPTER IX.

Third Basin from the Sinnemahoning southward into Indiana County, ... 538
Bennett's Branch, ... 539

CHAPTER X.

The Fourth Basin south-westward into Jefferson County, 540
Brandycamp, ... 543
Luthersburg, ... 545

CHAPTER XI.

Fifth and Sixth Basins in Potter, McKean, Elk, and Forest counties, ... 546
Limestone, ... 548
Bog iron-ore, ... 549
Clarion River, ... 553

CHAPTER XII.

The Sixth Basin south-westward, ... 553
Tunamaguont, ... 555
Alleghany River near Warren, ... 557
Seral Conglomerate, north-west limit, . . . 557
Tionesta Coal Group, north-western limit, . . . 558
North-western limit of the Sixth Basin, from French Creek westward to the Ohio line, . . . 558
West of the Shenango River, ... 560

CHAPTER XIII.

The North-western side of the Sixth Basin—*Continued*, 561
The Tionesta Coal, from Franklin westward, . . 561
Upper and Lower Porter coals, ... 563

PAGE

CHAPTER XIV.

North-western border of the Sixth Basin—*Continued*, 564
Mercer and the Beaver River, ... 564
Mercer, ... 565

CHAPTER XV.

Sixth Basin in Jefferson and Clarion counties; Coal-beds above the Tionesta Sandstone, ... 567
The Clarion Coal-bed, ... 567
Bog iron-ore, ... 568
The buhrstone or chert, ... 568
Clarion, ... 569
Western side of the Clarion, ... 570

CHAPTER XVI.

Sixth Basin; south-east-dipping Clarion Group; region west of the Alleghany River, ... 572
South-east-dipping Clarion Group, ... 575

CHAPTER XVII.

Sixth Basin west of the Alleghany River—Freeport Group, 576
Freeport Group, ... 577
Sugar Creek Section, Great Western Furnace, . 577

CHAPTER XVIII.

Freeport Group, Sixth Basin, and country west of the Beaver River, ... 580
Lower Freeport Coal, ... 582
The Kittanning Coal-bed, ... 582
The Ferriferous Limestone, ... 582

CHAPTER XIX.

Country watered by the Red Bank Creek, Jefferson County—Fifth Basin, ... 583
Red Bank Creek, ... 585

CHAPTER XX.

Country on the Mahoning and Cowanshannock waters, Third and Fourth Basins, Indiana and Armstrong counties, ... 586
Third and Fourth Basins, ... 587

CHAPTER XXI.

Third Basin, in Indiana County, ... 589
Black-Lick and Crooked Creeks, ... 589
Crooked and Plum Creeks, ... 591

CHAPTER XXII.

Fourth and Fifth Basins—Kittanning and Freeport—Crooked Creek and the Kiskiminetas, . . . 592
Kittanning, ... 593
Freeport, ... 595
Leechburg and Warren, ... 597
Saltzburg, ... 599

CHAPTER XXIII.

Third Basin—First Subdivision, along the Conemaugh: Lower and Middle Coal-measures, . . . 599

PAGE

CHAPTER XXIV.

1. Lower rocks of the First Sub-basin, of the Third Basin, between the Loyalhanna and the Conemaugh, along the base of Chestnut Ridge, . . 603
Coal-beds of Loyalhanna Creek, . . . 603
2. Lower rocks south of the Loyalhanna, along Chestnut Ridge, ... 604
Coal-beds on the Big Sewickly, First Sub-basin and Axis, ... 604
3. Third Basin, First Subdivision, along Jacob's Creek, 607
Jacob's Creek, ... 607
4. Jacob's Creek in the Second Sub-basin, . . 608
5. Lower Coals and Barren measures along Mount's Creek, ... 609
Youghiogheny, ... 611
6. Lower rocks southward of the Youghiogheny, . 612
West base of Chestnut Ridge, . . . 615

CHAPTER XXV.

1. Pittsburg Coal-bed, and the rocks above it, in the Third Basin south of the Conemaugh, . . 616
2. Pittsburg Coal, south of the Loyalhanna—First Sub-basin, ... 617
3. The Pittsburg Coal-bed southward of the Sewickly, 618
4. Rocks above the Pittsburg Coal, south of the Sewickly Creek, in the First Subdivision of the Third Basin, 619
5. Pittsburg Coal, south of Jacob's Creek, . . 620
6. Pittsburg Coal, south of Youghiogheny River, . 622
7. Rocks above the Pittsburg Coal, south of the Youghiogheny River, ... 623
8. Pittsburg Coal, and strata overlying it, along the Redstone Creek, and southward, . . . 624
9. Pittsburg Coal-bed south-westward from Redstone Creek, ... 625
10. Pittsburg Seam, upon the First Sub-axis, between Redstone Creek and George's Creek, . . 626
11. Rocks above the Pittsburg Coal, south of Redstone Creek, ... 628

CHAPTER XXVI.

1. Second subdivision of the Third Coal-basin west of the First Sub-axis south of the Conemaugh—upper group, ... 628
2. Rocks above the Pittsburg Coal-bed, Second Subdivision of Third Basin, ... 629

CHAPTER XXVII.

Alleghany and Monongahela Rivers, in the neighbourhood of Pittsburg, ... 630
Black fossiliferous limestone, ... 631
Grey sandstone, ... 632
Barren measures, ... 633
Pittsburg Limestone, ... 634
Pittsburg Coal, ... 634
The Great Limestone, ... 635

CHAPTER XXVIII.

Third Subdivision of the Third Great Basin south of the Greensburg and Pittsburg Turnpike, . . 636
From McKeesport to Robbstown (West Newton), along the Youghiogheny River, ... 637
Perryopolis, ... 639

PAGE

Rocks above the Pittsburg Coal, west of the Second Sub-axis, and south of the Pittsburg and Greensburg Turnpike, ... 640
Williamsport, ... 641
Brownsville, ... 643
Upon the road from Brownsville to Uniontown, . 644

CHAPTER XXIX.

Country south of the Conemaugh, in the First and Second Basins, in Somerset and Fayette counties, . 650
First or Salzburg subdivision of the First Basin, . 650
Second and third divisions of the First Basin, . 652
Johnstown, ... 653
Stony Creek and Paint Creek, . . . 655
Laurel Hill Creek, ... 657
Castleman's River, ... 659
Second Basin, ... 660
Lockport, ... 661
Indian Creek, ... 663

CHAPTER XXX.

Of the thin group of coal strata between the Umbral red shale and the main Seral conglomerate, in Somerset and Fayette counties, ... 665

PART III.

MESOZOIC RED SANDSTONE SERIES.

INTRODUCTORY CHAPTER.

Geographical limits of the Mesozoic red sandstone, . 667
Composition of the Mesozoic red sandstone, . . 669
Of the dip of the strata, ... 670
Igneous rocks of the Mesozoic red sandstone, . 671

CHAPTER I.

Detailed description of the Members of the Mesozoic series, ... 672
Red shale and sandstone, ... 672
Boundary of the Mesozoic red sandstone in the Chester County lead-mining district, . . . 675
Of the red shale and sandstone in York and Adams counties, ... 677
Section along the west side of the Susquehanna, . 677

CHAPTER II.

Lower calcareous conglomerate west of the Susquehanna, 679

CHAPTER III.

Upper calcareous conglomerate, ... 681
Upper calcareous conglomerate south-west of the Susquehanna, ... 682

CHAPTER IV.

Trap-dykes of the Mesozoic belt, and alterations produced in the strata in contact with them, . . 684
Trap-dykes west of the Susquehanna, . . 687
Organic remains and geological age, . . . 692
Question of age, ... 693
Red sandstone of the Connecticut Valley, . . 694

PAGE

Organic remains of the main red sandstone belt of the Atlantic slope, ... 695
Fossils of the Mesozoic belts of Virginia and North Carolina, ... 696

PART IV.

IGNEOUS ROCKS AND MINERALS, VEINS AND ORES.

Mineral veins of the Pickering Creek Valley, near Phœnixville, ... 699
Geological relations of the mineral veins, . . 699
The Wheatley Lode and its mines, . . 701
Trap-dykes of the Wheatley Lode, . . . 702
The trap-dykes in the Wheatley Lode, . . 703
Extent and condition of the Wheatley Mine in 1853, 703
Product of the mine in ore, ... 704
Branches from the main lode in the Wheatley Mine, 704
The present extent of the Brookdale Mine, . 705
Mineral veins and metalliferous deposits of the gneissic region north of the Chester County Valley, . 706
Granitic and trappean dykes, . . . 706
Prevailing direction of the granite dykes, . . 706
Trap-dykes, ... 706
Metalliferous veins, ... 706
Knauertown iron and copper veins, . . 706
Elizabeth Copper Mine, ... 707
Steel's Iron-ore Pits, ... 707
Hopewell Furnace Ore-pits, . . . 707
Warwick Iron Mines, ... 707
Leighton Iron-ore Mine, ... 707
Warwick Iron Mine proper, . . . 708
Knauertown Iron Mine, ... 709
Other mineral veins in the northern gneissic district, 709
Old Copper Mine, on Copper Mine Run, in Bath township, in Lancaster County, ... 709
Localities of well-characterised crystalline minerals within the gneissic districts of Pennsylvania, . . 709
Minerals in the southern gneissic district, . . 709
Minerals in the middle gneissic district occurring in the genuine or older gneiss, . . . 710
Minerals of the northern gneissic district, or of the South Mountains and their spurs between the Delaware and Schuylkill, ... 710
Minerals of the metamorphic Primal strata, and of the middle range of the southern gneissic district, possibly the same formation under more extreme metamorphism, ... 710
Altered Primal slates, ... 711
Localities of minerals associated with the Auroral limestone, ... 712
Southern metamorphic district, . . . 712
Middle metamorphic district, . . . 712
Northern metamorphic district, or South Mountains, 712

ON THE IRON ORES OF THE GNEISSIC AND PALÆOZOIC FORMATIONS OF PENNSYLVANIA.

Introductory Remarks, ... 712

CHAPTER I.

Of the iron ores of the metamorphic or gneissic rocks, 713
Magnetic iron-ore, or oxidulated iron, . . 713
Metalliferous veins of the South Mountains, . . 715
Iron ores of the gneiss, ... 715
Iron mines of the Lehigh Hill, . . . 715
Durham Iron Mine, ... 715
Mount Pleasant Iron Mines, . . . 715
Penn's Mount Ore-vein, ... 716
Analysis of iron ores of the Gneissic rocks of Pennsylvania, ... 717

CHAPTER II.

Iron ores of the Primal series, . . . 718
Cornwall Iron Mines, ... 718
Surface iron-ores of the Primal series, . . 720
Analyses of specimens of hydrous peroxide of iron of the Primal slates, Pennsylvania, . . . 721

CHAPTER III.

Iron ores of the Auroral and Matinal series, . . 722
Iron ores and mines of the Kittatinny Valley, . 722
1. Of the district between the Delaware and Lehigh rivers, ... 722
2. Of the district between the Lehigh and Schuylkill rivers, ... 723
Analyses of specimens of hydrous peroxide of iron, or hæmatite, of the Auroral Limestone, Pennsylvania, 727
Table of hæmatite iron-ores of the Auroral Limestone —*continued*, ... 728
Table of analyses of iron-ores of the Matinal slates, Pennsylvania, ... 728

CHAPTER IV.

Iron ores of the Surgent series, ... 729
Analyses of specimens of iron ore of the Surgent series, Pennsylvania, ... 731

CHAPTER V.

Iron ores of the Pre-meridian and Meridian series, . 731
Table of analyses of iron ores of the Pre-meridian series, ... 732

CHAPTER VI.

Iron ores of the Cadent and Vergent series, . . 732
Table of analyses of iron ores of the Cadent and Vergent strata of Pennsylvania, . . . 733

CHAPTER VII.

Iron ores of the Umbral series, . . . 734
Analyses of iron ores of the Umbral red shales of Pennsylvania, ... 734

CHAPTER VIII.

Iron ores of the coal strata, ... 735
On the origin and accumulation of the proto-carbonate of iron in Coal-measures, &c., . . . 737
Analyses of the carbonates of iron of the Coal-measures of Pennsylvania, ... 739

SKETCH OF THE GEOLOGY OF THE UNITED STATES.

Hypozoic and Azoic metamorphic rocks, . . 744
Gneissic rocks, ... 744
Description of the rocks, ... 744
Semi-metamorphic or Azoic strata, . . . 744
Metamorphic Palæozoic strata, . . 745

PAGE
Geographical distribution, ... 746
Minerals, ... 748
Palæozoic formations, ... 748
Primal series, or Potsdam sandstone of New York, 751
Auroral series, or Black River, and Chazy limestone and Calciferous sandstone of New York, . 752
Matinal series, or Trenton limestone and Hudson River slate group of New York, . . . 752
Levant series, or Medina Group of New York, . 753
Surgent series, or Clinton Group of New York, . 753
Scalent series, or Onondago Salt and Niagara Limestone Groups of New York, ... 754
Pre-meridian series, or Lower Helderberg limestone of New York, ... 754
Meridian series, or Oriskany sandstone of New York, 755
Post-meridian series, or Upper Helderberg limestone of New York, ... 755
Cadent series, or Genessee, Hamilton, and Marcellus Groups of New York, ... 755
Vergent series, or Chemung and Portage Groups of New York, ... 756
Ponent series, or Catskill Group of New York, . 756
Vespertine series, or lower Carboniferous strata, . 756
Umbral series, or middle Carboniferous strata, . 757
Seral series, or Coal-measures, ... 758
Upper Coal-measures; supposed Permian formation, 759
Mesozoic formations, or middle secondary strata, . 759
Mesozoic red sandstone, ... 760
Organic remains and geological age, . . 760
Dip of the red sandstone, and physical conditions attending its origin, ... 761
Trap-rocks, ... 763
Metalliferous veins, ... 763
Jurassic coal-formation, ... 763
Oolitic Basin, North Carolina, ... 764
Newer Mesozoic, ... 765
Cretaceous deposits, ... 765
Geographical distribution, ... 765
Organic remains and equivalents, . . . 766
Physical Geography of the Cretaceous era, . 767
Cainozoic or Tertiary formations, ... 767
Atlantic Belt, ... 767
Pacific Slope, ... 767
Central Tertiary tracts, ... 768
Eocene formations, Atlantic Slope, . . 768
Description of Eocene strata, ... 769
Fossils and geological equivalents, ... 769
Physical geography of the Eocene, . . . 770
Miocene strata of the United States, ... 770
Miocene on the Atlantic, ... 770
Pacific Belt, ... 770
Miocene strata of the central and western parts of the Continent, ... 771
Fossils and equivalents of the Miocene, . . 771
Nebraska Basin, ... 771
Miocene fresh-water basin of the Niobrara and White Rivers, ... 772
Pliocene and Pleistocene strata, ... 772
Pliocene and Pleistocene beds of Virginia and North Carolina, ... 772
Pliocene strata of Nebraska, ... 773
Californian Pleistocene beds, ... 773
Fossils of the Atlantic Pleistocene strata, . . 773
The northern Pleistocene, or great Boulder-drift, . 774
Southern limit of the Drift, ... 774
Striated rocky floor of the Drift, . . . 774
Pleistocene fossiliferous clays and sands, . . 775
Fresh-water Pleistocene of the Western States, . 775
Later local drift, ... 775

CONDITIONS OF THE PHYSICAL GEOGRAPHY ATTENDING THE PRODUCTION OF THE PALÆOZOIC STRATA OF THE UNITED STATES.

Sources of the sedimentary matter—state of the waters—changes of level of the sea-bottom—horizons of continuity and discontinuity, ... 776
Preliminary considerations, ... 776
Horizons of continuity and discontinuity, . . 777
Depositions and disturbances of the Primal period, 779
Depositions and disturbances of the Auroral period, 781
Auroral blue limestone, Chazy and Black River limestone of New York, ... 782
Disturbances of the crust at the end of the Auroral period, ... 783
Palæontological break between the Auroral and Matinal series, ... 783
Depositions and disturbances of the Matinal period, 783
Stupendous crust-movement and revolution in the earth's inhabitants at the close of the Matinal period, ... 784
Palæontological break at the end of the Matinal period, ... 788
Deposition and disturbances of the Levant period, 788
Deposition and disturbances of the Surgent series, 789
Deposition and disturbances of the Scalent series, 789
Deposition and disturbances of the Pre-meridian series, ... 790
Deposition and disturbances of the Meridian series, 790
Deposition and disturbances of the Post-meridian series, ... 791
Depositions and disturbances of the Cadent series, 791
Depositions and disturbances of the Vergent series, 792
Depositions and disturbances of the Ponent series, 793
Depositions and disturbances of the Vespertine series, 793
Depositions and disturbances of the Umbral series, 794
Of the limits of the Appalachian Coal strata, . 795
Nature of the Coal strata, ... 796
Of the phenomena connected with the Coal-seams, 799
Of the intimate mechanical structure of the Coal, . 800
Of the character of the strata in immediate contact with the Coal-seams, ... 802
Of the roof of the Coal, ... 803
Of the direct contact of coal-beds and marine limestones, ... 804
Theory of the origin of the Coal strata, . . 805
Gradation in the proportion of volatile matter in the Coal of the Appalachian Basins, . . . 808
Fossils of the Coal-formation, ... 810
Of the formative actions concerned in the production of the Palæozoic and other strata, . . . 811
Perpendicular deposition, ... 812
Stratification without suspension, . . . 812
Stratification from a state of suspension in water, 813

ORGANIC REMAINS OF THE PALÆOZOIC STRATA OF PENNSYLVANIA.

Fossils of the Primal strata, ... 815
Organic remains of the Auroral strata, . . 817

PAGE
Organic remains of the Matinal strata, . . 818
Matinal (Trenton) limestone, . . . 818
Organic remains of the Matinal shale, . . 820
Organic remains of the Levant strata, . . 821
Organic remains of the Surgent strata, . . 822
Organic remains of the Scalent strata, . . 824
Organic remains of the Pre-meridian strata, . 824
Organic remains of the Meridian strata, . . 825
Organic remains of the Post-meridian strata, . 826
Organic remains of the Cadent strata, . . 826
Organic remains of the Vergent series, . . 829
Organic remains of the Ponent rocks, . . 830
Organic remains of the Vespertine and Umbral strata, ... 830
Animal remains of the coal strata of Pennsylvania, 833
Notes on the Beyrichiæ and Leperditiæ of Pennsylvania, by T. Rupert Jones, ... 834
Fossil plants of the coal strata of Pennsylvania, . 835
General remarks on the distribution of the coal-plants in Pennsylvania, and on the formation of the Coal, 837
Description of the fossil plants found in the anthracitic and bituminous Coal-measures of Pennsylvania, 847
First class.—Fungineæ, ... 847
Second class.—Algæ, ... 848
Third class.—Muscites, ... 849
Fourth class. Calamariæ, ... 849
1. Calamites, ... 849
2.—Equisetites, ... 850
3.—Asterophyllites, ... 851
4.—Annularia, ... 852
5.—Sphenophyllum, ... 852
Fifth class.—Filices (Ferns), . . . 853
1. Neuropteridæ, ... 854
I. Noeggerathia, ... 854
II. Cyclopteris, ... 855
III. Neuropteris, ... 856
IV. Odontopteris, ... 860
V. Dyctiopteris, ... 861
II. Sphenopterideæ, ... 861
I. Sphenopteris, ... 861
II. Hymenophyllites, ... 863
III. Pachyphyllum, ... 863
III. Pecopterideæ, ... 864
Asplenites, ... 864
Alethopteris, ... 864
III. Callipteris, ... 865
IV. Pecopteris, ... 866
Ferns of undetermined affinity, . . . 868
Stems, ... 868
1. Caulopteris, ... 869
2. Psaronius, ... 869
3. Diplostegium, ... 869
4. Stigmaria, ... 869
5. Sigillaria, ... 871
6. Syrigodendron, ... 873
7. Lepidodendron, ... 873
8. Ulodendron, ... 875
Fruits, ... 875
1. Lepidophyllum, ... 875
2. Lepidostrobus, ... 876
3. Brachyphyllum, ... 876
4. Cardiocarpon, ... 876
5. Trigonocarpum, ... 877
6. Rhabdocarpos, ... 877
7. Carpolithes, ... 877
8. Cordaites, ... 877

CATALOGUE OF THE FOSSIL PLANTS WHICH HAVE BEEN NAMED OR DESCRIBED FROM THE COAL-MEASURES OF NORTH AMERICA.

Filices or fern leaves, ... 878
Neuropterideæ, ... 878
Sphenopterideæ, ... 879
Pecopterideæ, ... 879
Leaves of doubtful affinity, ... 880
Asterophylliteæ, ... 880
Stems of trees, ... 881
Cones or catkins and their scales, . . . 883
Fruits or nutlets, ... 883

ON THE LAWS OF STRUCTURE OF THE MORE DISTURBED ZONES OF THE EARTH'S CRUST.

Wave-like form of all upraised tracts of the crust, . 885
Exemplified in Pennsylvania and in the United States generally, ... 885
Parallelism of the crust-undulations, . . 886
Relations of flexures to each other, . . 887
Forms of the waves, ... 888
Symmetrical flexures, ... 888
Normal flexures, ... 888
Folded flexures, ... 889
Axis-planes, ... 890
Crust-waves, straight and curvilinear, . . 890
Flexures or waves of the strata, regarded longitudinally, ... 891
Of the distribution of flexures into groups, . . 892
Gradations in flexures, ... 892
Gradation from the folded to the symmetrical waves, 892
Gradations of structure in individual flexures exemplified, ... 892
Progressive expansion of the waves in one direction, 893
Exceptions to the prevailing law of steeper north-west than south-east dips in the Appalachian chain, 894
Progressive flattening-down of the flexures, . 895
Fractures or faults in tracts of undulated strata, . 895
General parallelism of the faults to the axis-planes, 897
Dislocation at an anticlinal axis-plane—uninverted side of wave shoved over the inverted, . . 897
Dislocation at a synclinal axis-plane, . . 898
Instances of great longitudinal dislocations, . 898
Exemplification of the laws of flexure by the phenomena of some of the undulated zones of Europe, 899
Analogous phenomena of axes in Great Britain and Ireland, ... 899
Belgium and the Rhenish Provinces, . . 900
The Jura Chain of Switzerland, . . . 901
The Alps, ... 901
The fan-like structure of the Alps, . . . 901
General phenomena of slaty cleavage in the Appalachians, and other zones of plicated strata, . 902
Cleavage approximately parallel with the strike, but independent of the dip of the strata, . . 902
Fan-like arrangement of the cleavage at the anticlinal and synclinal axis-planes, . . . 903
Relation of cleavage to the mechanical constitution of the strata, ... 903

PAGE
The cleavage susceptibility alternately greater and less in parallel planes, ... 904
Foliation, ... 904
Examination of the prevailing theories of elevation, 905
Hypothesis of wedge-like intrusion of melted matter, 905
Intrusion of the igneous rocks in solid wedges, . 906
The upward movement of an igneous dyke would tend to stretch and not to corrugate the flexible strata, 906
Theory of upward tension against lines or points of the crust, ... 906
Hypothesis of corrugation from sinking of tracts of the earth's surface, ... 907
Hypothesis of a simple horizontal compression, . 907
Views of geologists concerning cleavage and foliation, 907
Examination of the prevailing theories of cleavage and foliation, ... 909
Theoretical views, ... 911
Theory of the flexure and elevation of undulated strata, 911
Theory of cleavage structure, ... 911
General Resumé, ... 912

CLASSIFICATION OF THE SEVERAL TYPES OF OROGRAPHIC STRUCTURE VISIBLE IN THE APPALACHIANS AND OTHER UNDULATED MOUNTAIN-CHAINS.

Features of General Erosion, ... 917
1. Erosion of horizontal strata, ... 917
a. Where each principal stratum is homogeneous as respects it hardness or softness, . . 917
b. Where each separate stratum is complex in composition and degree of hardness, . . . 918
2. Features of erosion of monoclinal belts, . . 919
a. Where the strata are alternately firmly and feebly cohering, and those of each class are alike hard and soft, ... 919
b. Where there are several groups of strata differing in their degrees of hardness, ... 920
3. Features of erosion in anticlinal belts, . . 921
a. Where the lowest strata exposed, or those of the anticlinal axis or summit of the wave, are the hardest, 921
b. Where the lowest strata exposed along the anticlinal axis are softer than those resting on them, 922
4. Features of erosion in synclinal belts, . . 924
a. Where the highest strata exposed, or those of the synclinal axis or trough of the wave, are the hardest —of this class there are several varieties, . 924
b. Where the highest strata embraced in the synclinal flexure are relatively soft—of this class likewise there are several varieties, ... 924
Features of Local Erosion, ... 927
5. Local erosion of horizontal strata, . . . 927
a. Where the strata have the same general degree of hardness, ... 927
b. Where the strata alternate in hardness, . 928
6. Local erosion of monoclinal strata, . . 929
a. Transverse ravines, ... 929
b. Longitudinal ravines in monoclinal belts, . 932
7. Local, ... 933
a. Erosion of anticlinal ridges, . . . 933
b. Gaps or notches in anticlinal ridges, . . 933
8. Features of local erosion of synclinal belts, . 636
a. Erosion of the ends of synclinal ridges, . . 936
b. Erosion of the ends of synclinal valleys, . 937
c. Local erosion of synclinal belts, connected with transverse gaps or notches, ... 938
d. Lateral gaps and breaches in synclinal basins, . 939
e. Modifications of the phenomena of general and local erosion dependent on wide deviations from symmetry of structure in the anticlinals and synclinals, 940
9. Denudation of unsymmetrical anticlinal belts, . 940
a. Erosion of unsymmetrical anticlinal ridges, . 940
b. Erosion of unsymmetrical anticlinal valleys, . 941

COAL-FIELDS OF THE UNITED STATES AND BRITISH PROVINCES.

CHAPTER I.

Description of the Coal-fields of the Provinces of British America, ... 942
Coal-field of New Brunswick, ... 945
Carboniferous district of Colchester and Hants, . 947
Carboniferous district of Pictou, . . . 948
Carboniferous district of Sydney County, . . 950
Carboniferous district of Guysborough, . . 950
Carboniferous district of Richmond and South Inverness, 951
Carboniferous district of Northern Inverness and Victoria, ... 952
Carboniferous district of Cape Breton County, . 952

CHAPTER II.

General description of the great Appalachian Coal-field, 954
Limits and dimensions, ... 954
Composition of the Coal-measures, . . . 956
Coal-beds, ... 957

CHAPTER III.

Illinois and Indiana Coal-field, . . . 959
General description, ... 959
Western Kentucky Coal-field, . . . 961
La Salle Coal-field, ... 964

CHAPTER IV.

Iowa and Missouri Coal-field—general description, . 964
Subdivisions of the Coal-measures, . . . 966
Composition of the Coal-measures, . . . 966
Organic remains, ... 967
Iron ores, ... 967

CHAPTER V.

Michigan Coal-field, ... 967

CHEMICAL CONSTITUTION AND PHYSICAL CHARACTERS OF THE BEST-KNOWN COALS OF NORTH AMERICA.

British Provinces, ... 969
United States, ... 969
Pennsylvania, ... 969
Virginia, ... 971
Kentucky, ... 973
Indiana, ... 974
Southern Illinois, ... 974
Middle Illinois, ... 975
Northern Illinois, ... 976
Missouri, ... 976

BRITISH COAL-FIELDS.

The Great South Wales Coal-field, . . . 977
North Wales Basin, ... 978
Forest of Dean, ... 978
Coalbrookdale, ... 978

PAGE
South Staffordshire Coal-field, . . . 978
North Staffordshire Coal-field, . . . 979
Bristol Coal-field, ... 979
The Yorkshire and Great Central Coal-field, . . 979
The Ashby-de-la-Zouch Coal-field, . . . 980
The Derbyshire Coal-field, ... 980
The Nottingham Coals, ... 980
The Lancashire and Yorkshire Coal-field, . . 980
Coal-field of Durham and Newcastle, . . . 980
Cumberland Coal-field, ... 981
Scotch Coal-fields, ... 982
The Mid-Lothian Coal-field, . . . 983
Lanarkshire Coal-field, ... 983
Renfrewshire Coal-field, ... 984
Ayrshire Coal-field, ... 984
Fifeshire Coal-field, ... 985
Dunfermline Coal-field, ... 985
Clackmannan Coal-field, ... 985
Irish Coal-fields, ... 985
Ballycastle Coal-field, ... 986
General Summary, ... 987
Table of Coal Produce of Great Britain and Ireland, 1854 and 1855, ... 987

COAL—ITS COMPOSITION, AND A CLASSIFICATION AND DESCRIPTION OF ITS VARIETIES.

The Anthracite Coals, ... 991
The True or Dry Anthracite, ... 991
Semi-Anthracite, or Soft Gaseous Anthracite, . 993
The Bituminous Coals, ... 994
Hydrogenous Coal, ... 995
Causes of the gradations in Coal, . . . 995
Conditions in the composition and structure of Coal affecting its economic value, . . . 997

PAGE
Table showing the relative properties and economic rank of the different classes of coal, . . 1000

METHODS OF SEARCHING FOR, OPENING, AND MINING COAL, PURSUED IN PENNSYLVANIA.

Searching for Coal, ... 1007
Surface-shafting, ... 1008
Boring, ... 1009
Opening or Proving Coal-seams preliminary to mining, 1009
Methods of mining Coal, ... 1010
Open Cut, ... 1010
By Drift, ... 1010
By Tunnels, ... 1011
By Slope, ... 1012
Introduction of Coal as a domestic fuel, . . 1012

AMERICAN AND EUROPEAN COAL-FIELDS.

Actual and relative areas—thickness and amount of coal in them—and present annual product of their mines, ... 1015
Areas of Coal-fields, ... 1015
Comparative quantities of fuel in coal-lands and forest-lands, ... 1017
Dynamic value of coal, ... 1017
Amount of coal mined, ... 1018
Coal-trade of Pennsylvania, ... 1018
Anthracite Coal-trade of the United States, . . 1019

STATISTICS OF THE IRON-TRADE.

Production and manufacture of iron in the United States, ... 1020
Nickel, and copper mine of the Gap, Lancaster County, 1022
Additional sections, ... 1023

GLOSSARY, ... 1025

INDEX, ... 1028

ILLUSTRATIONS

IN THE

SECOND VOLUME.

SKETCHES OF SCENERY, &c.

FRONTISPIECE—BALTIMORE COMPANY'S MINES, WILKESBARRE.

SADDLE COAL-BED, NESQUEHONING MINES, ... *to face page* 60

LEHIGH SUMMIT, EAST MINE, ... 65

EAST WORKINGS IN OLD LEHIGH SUMMIT MINE, ... 66

MOUNT PISGAH PLAIN, MAUCH CHUNK, ... 73

PICTORIAL SECTION, EAST SIDE OF THE LITTLE SCHUYLKILL, AND NORTH SIDE OF THE COAL BASIN, TAMAQUA, ... 78

NEWKIRK (NEWARK ON PLATE) TUNNEL COLLIERY, NEAR TAMAQUA, ... 98

SILVER CREEK COLLIERIES IN 1853, SHOWING THE COAL-BREAKERS AND MOUNDS OF SLATE, ... 120

POTTSVILLE IN 1840, FROM THE NORTH, SHOWING THE GAP IN SHARP MOUNTAIN, ... 144

ROARING BROOK FALLS, NEAR SCRANTON, ... 338

INTERIOR OF BALTIMORE COMPANY'S OLD MINE, WILKESBARRE, ... 382

NANTICOKE GAP, WYOMING VALLEY, ... 399

LAUREL HILL AND PLAIN OF WESTERN PENNSYLVANIA, ... 468

PITTSBURG IN 1840, FROM GRANT'S HILL, ... 630

MAP OF THE MINING DISTRICT OF CHESTER AND MONTGOMERY COUNTIES, ... 675

SPANISH HILL, NEAR ATHENS, TIOGA COUNTY, A REMNANT OF A HIGH TERRACE OF NORTHERN DRIFT, ... 774

QUARRIES IN AURORAL LIMESTONE ON THE SCHUYLKILL, ILLUSTRATING CLEAVAGE, ... 905

COAL BENCHES, LOCUST MOUNTAIN, OPPOSITE LEHIGH SUMMIT MINES, ... 1008

OVERTURNED OUTCROP NEAR NEWKIRK, PENNSYLVANIA, ... 1008

OLD DRIFT IN THE FOURTEEN-FEET SEAM, NESQUEHONING MINES, ... 1011

COLLIERY SLOPE AND BREAKER AT TUSCARORA, ILLUSTRATING THE MANNER OF LIFTING THE COAL, AND BREAKING AND SORTING IT FOR THE MARKET, ... 1012

MAP OF THE ANTHRACITE AND BITUMINOUS COAL-FIELDS OF PENNSYLVANIA, ... 1019

TWENTY PLATES OF "FOSSILS OF COAL-FORMATION" (AT END OF VOLUME).

GEOLOGICAL SECTIONS.

PLATE I.—SECTION ON THE LITTLE SCHUYLKILL RIVER, NEAR TAMAQUA.
SECTION ON CASCA WILLIAM CREEK FROM MINE HILL TO MIDDLEPORT.
SECTION ON SILVER CREEK, EAST SIDE.
SECTION ON MILL CREEK FROM BROAD MOUNTAIN TO THE SCHUYLKILL RIVER.

PLATE II.—SECTION ON EAST NORWEGIAN CREEK FROM MINE HILL SOUTHWARD.
SECTION OF GATE RIDGE, POTTSVILLE.
SECTION ON MIDDLE NORWEGIAN CREEK.
SECTION ALONG WEST NORWEGIAN CREEK.
SECTION ON WEST BRANCH AND WOLF CREEK.
SECTION ON WEST-WEST BRANCH FROM MINE HILL TO SILVERTOWN.

PLATE III.—SECTION ON SWATARA CREEK.
SECTION ON LITTLE MUDDY BRANCH, BETTINGER'S MINES.
SECTION OF THICK MOUNTAIN NORTH OF DONALDSON.
SECTION OF BIG LICK MOUNTAIN.
SECTION ON MUDDY BRANCH AT WEAVER'S.
SECTION OF RED MOUNTAIN, TREMONT.
SECTION OF SHARP MOUNTAIN AT SWATARA AND RAUSCH GAPS.
SECTION ON RAUSCH CREEK FROM LITTLE LICK MOUNTAIN TO SHARP MOUNTAIN.
SECTION AT BEAR GAP, WICONISCO BASIN.
SECTION OF KLINGER'S GAP, WICONISCO BASIN.

PLATE IV.—SECTION FROM LAUREL HILL SLOPE (HAZLETON) TO SPRING MOUNTAIN.
SECTION ALONG WILKESBARRE AND TAMAQUA TURNPIKE FROM BUCK MOUNTAIN TO SPRING MOUNTAIN.
SECTION ON CATAWISSA ROAD AND THROUGH MAHANOY GAP NEAR ASHLAND, MAHANOY BASIN.
SECTION EAST OF MOUNT CARMEL.
SECTION FROM SHAMOKIN MOUNTAIN TO LOCUST MOUNTAIN.
SECTION ON LANDS OF BIG MOUNTAIN COMPANY ACROSS HEAD-WATERS OF GERHART'S RUN, TO LOCUST MOUNTAIN.

PLATE V.—SECTION DOWN ROARING BROOK AND THROUGH SCRANTON TO THE TURNPIKE ROAD WEST OF THE DIAMOND MINES.
SECTION FROM M'FARLANE'S SHAFT SOUTH-EAST TO THE BACK ROAD.
SECTION EAST FROM WILKESBARRE BY CANAL *VIA* WILLIAMS' STORE TO GARDINER CREEK.
SECTION ON PITTSTON PLANK-ROAD FROM BENEDICT'S MINE TO SHAFT NO. 4.
SECTION FROM CANAL ALONG EASTON TURNPIKE TO PROSPECT ROCK.
SECTION ON ROAD FROM CANAL TOWARDS SOLOMON'S GAP.
SECTION OF SOLOMON'S GAP.

PLATE VI.—SECTION ACROSS THE BASIN AT THE LEHIGH SUMMIT MINES.
SECTION HALF A MILE WEST OF EYSTER OR ZERBE'S GAP, TREVORTON.
SECTION SHOWING LONGITUDINAL PROFILE OF LITTLE LICK MOUNTAIN.
SECTION WEST SIDE OF EYSTER GAP, TREVORTON.
SECTION FROM SUSQUEHANNA RIDGE TO WARRIOR PATH GAP.

PLATE VII.—SECTION ALONG THE PENNSYLVANIA CENTRAL RAILROAD FROM PITTSBURG TO THE ALLEGHANY MOUNTAIN.

PLATES I.-XX.—FOSSILS OF THE COAL-FORMATION.
PLATES XXI. AND XXII.—PLANTS OF THE VESPERTINE AND UMBRAL SERIES.

VIEWS AND SECTIONS

(*PRINTED IN THE TEXT*—CONTINUED FROM VOL. I.)

FIG.		PAGE
137.	Subdivisions of the Coal Series of Pennsylvania,	16
138.	Section of the Coal Strata at Rhume Run, looking east,	54
139.	Section of Coal, No. 6, Rhume Run,	58
140.	Ground-Plan of Old Mine in the No. 6 or Thirty-nine-feet Coal at Rhume Run,	58
141.	Saddle of the Big Coal of Rhume Run at the Short Tunnel,	61
142.	Subdivision of the great Coal-bed of Summit Mines,	65
143.	Coal C of Tamaqua,	78
144.	Coal D of Tamaqua,	78
145.	Coal E of Tamaqua,	79
146.	Greenwood Tunnel, in Locust Mountain,	83
147.	Anticlinal Axis B, near Newkirk, with overturned outcrop,	97
148.	Section of Newkirk Tunnel,	98
149.	Coal (B ?) C, Newkirk Tunnel,	101
150.	Coal F (thickened), Newkirk Tunnel,	101
151.	Buckville Tunnel,	102
152.	Coal E, Buckville,	103
153.	Tuscarora, or Palmer Coal of Tuscarora,	103
154.	Coal E, Palmer Tunnel,	103
155.	Grier Coal, Tucker's Slope,	103
156.	Palmer Coal, Tucker's Slope,	104
157.	Section of Strata at east end of Mine Hill, N. of Patterson, looking east,	104
158.	Whitfield Tunnels,	105
159.	Section of the Basin C, at Tucker's Slope, head of Tuscarora Creek,	106
160.	Section of Palmer's Tunnel near Tuscarora S.,	106
161.	Section of Red-Ash Coals east of Tuscarora, looking east,	107
162.	Coals, east end of Church Hill at Tuscarora,	107
163.	Beachem's Tunnel entering Sharp Mountain south-west of Tuscarora, looking east,	110
164.	Milford Tunnel,	113
165.	Section at Preston's (Neville's) Colliery off New Philadelphia, looking east,	118
166.	Section at Cwmbola from anticlinal J, looking east,	126
167.	Section of Tunnel in Bare Ridge (Pott and White's),	127
168.	Section on Zachariah's Run, looking east,	129
169.	Ravensdale Tunnel,	130
170.	Mann and Williams' Tunnel, Mount Laffy, looking east,	141
171.	Section of Salem Hollow, looking east,	151
172.	End view of Gate Ridge (Lawton's Hill), Pottsville, looking east,	152
173.	Morgan and Edward's Tunnel, Otto Tract, looking east,	157
174.	Bast and Pearson's Slope,	171
175.	Serril's Upper Tunnel, Wolf Creek, looking east,	171
176.	Section, with Pictorial Background, of the Southern Coal-field near Tremont, looking west,	180
177.	Tunnel in the Thick Mountain N. of Donaldson, looking east,	181

FIG. PAGE
178. Strata in Big Lick Mountain, ... 182
179. Strata in Red Mountain, ... 184
180. Section of south side of Red Mountain at Hebbard's Tunnel, 2 miles east of Tremont, looking east, . . 185
181. Section at Black Spring Gap, Dauphin Basin, . . 194
182. Section at Rausch Gap, Dauphin Basin, . . 195
183. Section at Yellow Spring Gap, Dauphin Basin, . 196
184. Section at Big Flats, Dauphin Basin, . . . 198
185. Section at M'Ginnis's Colliery, Coal Castle, looking east, 205
186. Dyer's Run, Sando's Colliery, about 1 mile west of M'Ginnis's, ... 206
187. Heckscherville Tunnel, looking east, . . . 207
188. Mecke's Tunnel, Meckesburg, looking east, . . 208
189. Mill Creek Basin, Broad Mountain, . . . 226
190. West Branch Basin, Broad Mountain, . . . 226
191. Coal Strata at the Little Schuylkill, . . . 227
192. Coal Strata on Silver Creek, ... 228
193. Coal Strata on Mill Creek, ... 229
194. Coal Strata in the Gorge of Mill Creek, opposite Wolf Creek (for comparison), ... 229
195. Coal Strata on West Branch and Wolf Creek, . 230
196. Coal Strata in the Thick Mountain at Donaldson, . 232
197. Section of the Sharp Mountain, looking west, showing overtilted strata and crushed coal-seams, . . 234
198. Flexure in Red Mountain Coal-bed, Lorberry Creek, . 235
199. Section of a Swell in the Big Coal of Lorberry Creek, Pinegrove, ... 236
200. Successive Phases of a Dislocated Flexure, . . 237
201. Cross Fractures displacing a Coal-seam, . . 237
202. Dislocation causing a Double Outcrop at Peach Mountain Seam near Minersville, ... 237
203. Section of "a Trouble" in a Coal-seam, . . 238
204. Coal of Wharton Creek, east of Jeanesville, . . 248
205. Big Coal, Jeanesville, at "Open Cut," . . 250
206. Big Coal, Beaver Meadows, ... 250
207. East End of Spring Mountain, . . . 251
208. Spring Mountain at Confluence of Beaver and Dreck Creeks, ... 251
209. Buck Mountain Basins, East Pismire Hill, . . 252
210. Section one mile east of Hazleton, . . . 252
211. Hazleton Basin, east of the Board Yard, . . 254
212. Coal Strata, Hazleton, ... 256
213. Big Coal of Hazleton—General Type, . . . 257
214. Big Coal, Hazleton, ... 258
215. Black Creek Basin, east of the Wilkesbarre Turnpike, . 261
216. East end of Little Black Creek Basin, Buck Mountain, 262
217. Buck Mountain, or Little Black Creek, east of the Wilkesbarre Turnpike, ... 262
218. Little and Big and Black Creek Basins, near the junction of the two branches of Black Creek, . . . 262
219. Buck Mountain, west of Black Creek Gap, . . 263
220. West end of Buck Mountain, ... 263
221. Section of East Green Mountain Basin, . . 264
222. Coal-bed of M'Cauley's Mountain, . . . 264
223. One of the Cave Workings in the South Mine of the Great Lehigh Summit Coal-seam, . . . 264
224. General Section from Little Mountain to Broad Mountain, across the Shamokin and Mahanoy Basins, east of Big Mine Run, ... 266
225. East end of Head Mountain, looking west, . . 266
226. Head Mountain, south-west side of Lindner's Gap, . 268
227. Mahanoy Basin at eastern Origin of Bear Ridge axis, . 268
228. Broken Anticlinal Crest of Bear Ridge, half a mile east of the Ridge, ... 268
229. Section west of Mouth of North Mahanoy, looking west, 269
230. Section of east End of the Mahanoy Coal-field, . 269
231. Section at the Bear Ridge Tunnel, . . . 269
232. Western Origin of Bear Ridge Axis, . . . 270
233. Bear Ridge Tunnel, Mahanoy Basin, looking east, . 270
234. Mammoth Coal, Big Mine Run, . . . 276
235. Patterson's Coal, Little Mine Run, . . . 277
236. Section at Green Ridge Gap, ... 280
237. Connor's Mammoth Coal, Locust Run, . . 285
238. Eckel's Coal VIII., near Mount Carmel, . . 286
239. No. 1 Mine, Lancaster Colliery, . . . 287
240. No. 2 Mine, Lancaster Colliery, . . . 287
241. Section of Green Ridge and Red Ridge at North Branch of Shamokin Creek at the Collieries looking east, . 289
242. Luke Fidler Coal-seam, ... 296
243. Section of Shamokin Mountain at Shamokin Gap, looking east, ... 299
244. Coals VIII. and IX. on Sunbury Railroad east of Shamokin, ... 300
245. Lowest Coal, Zerbe's Gap, ... 311
246. Coal I, Zerbe's Gap, Trevorton, . . . 311
247. Coal II., west side of Zerbe's Gap, . . . 312
248. Coal III., near Zerbe's Gap, Trevorton, . . 312
249. Coal V., Zerbe's Gap, Trevorton, . . . 313
250. View of the Top Slate of Coal No. X., near Zerbe's Gap, Trevorton, showing matted flattened stems of Sigillaria, ... 317
251. Cobb's Gap, of Roaring Brook, . . . 319
252. Vespertine and Umbral Strata at Solomon's Gap, . 320
253. Umbral Red Shale, Nanticoke Mountain, at Nanticoke, 320
254. Vespertine and Umbral Strata, Hertzoff Hollow, north of Kingston, ... 321
255. Wilkesbarre Lower Coal-measures near Solomon's, . 322
256. Wilkesbarre Upper Coal-measures (mouth of Mill Creek), 322
257. Campbell's Ledge above Pittston, Susquehanna Gap, . 326
258. Coal-measures at Carbondale, ... 331
259. Great Bed, Carbondale, ... 332
260. Archbald, ... 334
261. Hull's Coal, 6 miles north-east of Scranton, . . 337
262. General Section of the Coal-measures at Scranton, . 339
263. Coal F (Big Bed), New York and Pennsylvania Company's Slope Mine, ... 340
264. Coal B, Roaring Brook, ... 347
265. Coal D, Scranton, near the Rolling Mills, . . 347
266. Section of Griffin Ravine west of Scranton, looking north-east, ... 348
267. Coals F (Big) and E, River Bluff, near the Bellevue Mines, ... 349
268. Big Coal F, Pinebrook Mines, ... 351
269. General Section, Diamond Mines, . . . 352
270. Shaft No. 2, Diamond Mines, . . . 353
271. Coal H, Washburn Mine, ... 354
272. Coals H and G, Shaft No. 2, Diamond Mines, . 354
273. Coal G, near the Fellows' Mine, . . . 354
274. Coal F, Shaft No. 2, Diamond Mines, . . . 354
275. Umbral Strata, showing position of Iron Ore, Stafford Meadow Brook, ... 358
276. General Section, Pittston and Port-Griffith, . . 361
277. Hollenback's Coal at opening near Canal, . . 369
278. Section at the Canal below the mouth of Mill Creek near Wilkesbarre, at the anticlinal flexure No. XVI., . 370
279. Section, Port Griffith Slopes and Borings, from Pennsylvania Company's draught, ... 373
280. Maxwell's Coal, ... 374
281. Wilcox Coal, Miner's Mill, ... 374
282. Lee's Coal, west side of Nanticoke Gap, . . 378
283. Baltimore Bed at Old Mine, south-east of Wilkesbarre, 381
284. Section of Anticlinal Flexure No. XIX., near the foot of the lower inclined plane, Solomon's Gap, looking west, ... 389
285. Stiver's Bed, ... 390
286. Lane's Tunnel, east of Solomon's Gap, . . 393
287. Baltimore Bed (Blackman's), east of Breaker, . 393
288. Lower Big Coal at Landmesser's, east of Solomon's Gap, 395
289. Grey and Landmesser's Tunnel, near Solomon's Gap, 395
290. Carey's Run, 1½ mile west of Solomon's Gap, . 396

FIG. PAGE
291. Section in Gulick's Gap, Bergman's Run, 397
292. Section from Lee's, southward, at Nanticoke, 399
293. Section across the Wyoming Coal-basin, 5 miles west of Nanticoke, or through Schleppy's, 400
294. Hog-Back, 5 miles west of Nanticoke, 401
295. Colt's Coal, 403
296. Contortions in Little Mountain, east of Susquehanna River, 403
297 (a), 297 (b), 404
298. Section across the Coal-basin at its Western End, 404
299. Column of Coal-measures visible in Shoemaker's Ravine, north of Kingston, 406
300, 406
301. Coals in Shoemaker's Ravine, 406
302, 406
303, 407
304. Reynold's Small Bed on Smith's Creek, 408
305. Great Plymouth Bed, Harvey's Mine, 410
306. Plymouth Big Bed, Lance's Grand Tunnel, 410
307. Levy and Patton's, 410
308. Gaylord's Coal, Cooper Bed, 411
309. Reynold's (Smith's) Great Bed, one mile north of Reynold's Tunnel, 412
310. Section on Smith's Creek, west of Plymouth, 412
311. Section from Conglomerate by Gaylord's Mine, north of Plymouth, 412
312. Ground Plan of the Otto White and Grey Ash Collieries, 434
313. Diagram of Spangler and Eckel's Gangways, 439
314. Topographical Sketch, Shirley's Knob, Broad-Top Mountain, 449
315. Schell's Coal, 452
316. Orbison's (Barnett) Coal, 453
317. Philip Barnett's, 453
318. Broad-Top Improvement Company's Coal, 453
319, 320. Cook's Coal, 454
321. Lear Bed, 458
322. Strata in Round Knob, 459
323. Coal near "Mountain House," 460
324. Sandy Run, 461
325. Hopewell Company's Coal, 462
326. Lick Run, 470
327. Red Run, Ralston, 470
328. South-east side of Laurel Hill, Conemaugh Gap, 471
329. North-west side of Laurel Hill, Conemaugh Furnace, 471
330. Section of Strata exposed on Pennsylvania Railroad, in western half of Chestnut Ridge Gap, 472
331. A general vertical section of the Bituminous Coal Strata of Pennsylvania, west of the Alleghany and Monongahela rivers, compiled from numerous local sections, embracing the belt of country from Mercer to Green counties, 475
332, 504
333. Loyalsock, 509
334, 510
335. Lycoming Creek, 510
336, 510
337. Section of Mountains, on sides of Schroeder's Branch, or Carbon Creek, Second Basin, 512
338. Fall Creek, 512
339. Towanda Creek, 513
340. Miller's, 513
341. Barclay's Drift, 513
342. Mason's Drift, 513
343. Section west of Gatiss's, Towanda Basin, 513
344. Ralston Old Mines, 514
345. Astonville, on Railroad, Ralston District, 515
346. Section of Hill at Cartersville, 1½ mile above Ralston, 516
347. Sellard's Ore, on Schroeder's Branch of Towanda Creek, 2 miles south of Canton, 517
348. Otter's Run, 518
349. Morris's Run Strata, near Blossburg, 519
350. Blossburg Strata, 520
351. Coal Run, 521
352. Bear Creek, 521
353. Blossburg Vespertine and Ponent, 522
354. East Creek, 522
355. Johnson's Creek, 522
356. Wilson's Creek, 523
357. Lick Run, Farrandsville, 528
358. Tangascootac Creek, 529
359. Beech Creek, 530
360. Snowshoe, 530
361. Moshannon, Phillipsburg, 531
362. Coal Hill, 532
363. Goss's Coal, 532
364. Section along the Susquehanna West Branch at Rattlesnake Run, showing the Vespertine Cliffs, 533
365, 534
366. Karthaus, 535
367. Curwinsville, 536
368. Clearfield Creek, 537
369. Caledonia, 539
370. Bennet's Branch Section, 539
371. At Emporium, 3d Basin, 541
372. Brandy Camp (opposite Horton's), 543
373. Little Toby Creek (Kyler's Coals), 543
374. Brandy Camp (Horton's), 543
375. Limestone Run, 543
376. Hemlock Run, 544
377. Reynoldsville, South Branch of Sandy Lick Creek, 544
378. Luthersburg, 545
379. Cliff Hill, 3 miles south of Wellsville, New York, 547
380. South of Smethport, 550
381. Potato Creek, 3 miles from Norwich, 550
382. Instantur, 551
383. Judge Wilcox's, 551
384. St Mary's (Fifth Basin), 552
385. Head-waters, South Branch Kenzua Creek, 554
386. Section exhibiting the two Sandstones overlying the Seral Conglomerate west of Smethport, with the Coal between, 554
387. Tunamaguont, 555
388. West of Kenzua, 556
389. South-west of Kenzua, 556
390. Little Alleghany River and French Creek, 556
391. Near Franklin, 556
392. Hills south-east of Alleghany River, near Warren, 557
393. Sugar Creek Lake, 559
394. Georgetown, and 10 miles north-east, 559
395. Two miles east and three miles south-west of Sharon, 560
396. Six miles north-west of Mercer, 560
397. Curtis's Coal, Sharon, 561
398. Four miles south-west of Franklin, 562
399. Three miles west of Sandy Creek Furnace, 562
400. A. Henderson's, Law's, &c., 562
401. Sandy Lake, 562
402. Three miles east of Mercer, 562
403. Mercertown, 565
404. Jenkin's Mill, 565
405. Mr Porter's, 565
406. Neshannock Creek, 565
407. Two miles west of Mercer, 565
408. Two miles above Newcastle, 566
409. One mile north-west of Newcastle, 566
410. Two miles below Newcastle, 566
411. Racoon Creek, Clarion River, 569
412. Lucinda Furnace, 569
413. Strattonville (three sections), 569
414. Deal's Bank, Shippensville, 571

FIG. PAGE
415. Deer Creek, ... 571
416. Scull's Run, ... 571
417. Rocklandtown, ... 571
418. Alsboch's, ... 571
419. Scrubgrass Creek, ... 573
420. Mercer, Sandy Lake, ... 573
421. Sandy Lake, ... 573
422. Lawrenceburg, ... 574
423. Slippery Rock Creek, ... 574
424. Beaver River, Newcastle Turnpike, ... 574
425. Neshannon Little Branch, ... 574
426. Lower Coal-measures, north-west Corner of Lawrence County, ... 575
427. Great Western Furnace, Sugar Creek, . . . 577
428. Alleghany River, 7 miles above Sugar Creek, . 578
429. Zelienople and Harmony, ... 579
430. Beaver River, ... 581
431. Old Brighton, ... 581
432. Below New Brighton, ... 581
433. On Ohio River, ... 581
434. Ohio River, Six-mile Run, ... 581
435. Armstrong's Mill, Clarion River, . . . 584
436. One mile below Troy, ... 584
437. Brown's Cannel Coal, ... 585
438. Red Bank, 6 miles below Troy, ... 585
439. New Bethlehem, ... 585
440. Reynolds' and Schunk's Furnace, ... 585
441. Mouth of Mahoning, ... 585
442. Two miles above mouth of Mahoning Creek, . . 586
443. One mile west and two miles south-west of Punxutawney, 586
444. Mean's, Mahoning, ... 587
445. Freeport Limestone, 5 miles below Punxutawney, . 587
446. Frampton's, ... 587
447. Dill's and Ewing's Mill, Mahoning Creek, . . 587
448. Smicksburg, ... 588
449, ... 588
450. Smith's Sawmill, ... 588
451. Two-Lick Creek, ... 590
452. Section compiled along Crooked and Plum Creek, . 591
453. Crooked-Creek Bend, ... 591
454. Kittanning, ... 593
455. Alleghany Furnace, ... 594
456. Shady Run, ... 595
457. Freeport, ... 595
458. Leechburg, ... 597
459, ... 597
460. Below Warren, ... 597
461. Warren, ... 597
462. Three miles above Warren, ... 598
463. Four and a half miles above Warren, ... 598
464. Three and a half miles below Saltzburg, on the Kiskiminetas, ... 599
465, ... 600
466. Opposite Blairsville, ... 600
467. Saltzburg, ... 601
468. Loyalhanna, ... 601
469, ... 605
470. Jacob's Creek, ... 607
471. Map of Mount's Creek, ... 609
472. Youghiogheny Section, ... 610
473, ... 610
474. Youghiogheny Section, lower part of Connellsville, . 611
475, ... 613
476. Section from Chestnut Ridge to the Pittsburg Coal-seam, 614
477, 478, ... 614
479, ... 615
480, 481, 482, ... 616
483. Pittsburg Coal-seam, ... 617
484. Pittsburg Coal-seam, ... 617
485. Loyalhanna River, ... 617
486. Conemaugh, ... 617
487, 488, ... 617
489. Pittsburg Coal, Nichol's Bank, ... 618
490, ... 618
491. Sewickly Creek, ... 618
492. Lemon's Coal, ... 619
493. Moyer's Coal, ... 619
494, ... 619
495. Byer's Coal, ... 619
496. Between Sewickly and Jacob's creeks, . . 620
497. Mount's Creek, ... 620
498. Connellsville, ... 621
499. Youghiogheny River, ... 621
500. Youghiogheny River, ... 621
501. Mount Braddock, ... 622
502. South of Mount Braddock, ... 623
503. National Turnpike, ... 623
504. Uniontown, Redstone Creek, ... 624
505. Redstone, ... 625
506. Oliphant's Furnace, ... 625
507. Virginia Line, ... 626
508. Cheat River, ... 626
509. Cheat River, Laurel Hill Gap, ... 626
510. Cat Run, ... 627
511. Newcomer's, ... 627
512. Smithfield, ... 627
513. Pittsburg Coal, ... 629
514. Loyalhanna, New Alexandria, ... 630
515. Type of Strata at Pittsburg, ... 631
516. Sewickly (Markle's Paper Mill), ... 636
517, 518, ... 636
519. Turtle Creek, ... 636
520, 521, ... 638
522. Sewickly Creek, ... 638
523. West of Robbstown, ... 638
524, ... 638
525. Big Sewickly Creek, ... 640
526. Youghiogheny River, ... 641
527. Williamsport, ... 641
528, ... 641
529, ... 642
530. Pike Run, ... 642
531. Below Greenfield, ... 642
532. Below Greenfield, ... 642
533. Brownsville, ... 642
534. Kreb's Knob, at Brownsville, ... 643
535. East of Brownsville, ... 643
536. Cox's Drift, ... 644
537. Mitchell's Drift, ... 644
538. Redstone Creek, ... 644
539. Brown's Run, ... 645
540. One mile above Brownsville, ... 646
541. Two miles and a half west of Carmichael, . . 646
542. Muddy Creek, ... 647
543. Whiteley Creek, ... 647
544. Mingo Creek, ... 648
545, 546, 547, 548, ... 650
549. Elk Lick Creek, ... 651
550. Elk Lick Creek, Salt Well, ... 651
551. Berlin, ... 651
552. Alleghany Summit, Pennsylvania Railroad, . . 652
553. Johnstown, ... 653
554. Stony Creek, ... 654
555. Below Red Bridge, on Stony Creek, ... 655
556. Paint Creek, ... 655
557. Rhoad's Camp, ... 655
558. Stoystown, ... 656
559. Milford and Ben's Creek, ... 657
560. Laurel Hill Creek, ... 657
561. Castleman's River, ... 658

FIG. PAGE
562. Castleman's River and Conglomerate Cliffs (in partial section), ... 658
563. Palæozoic Denudation, exhibited on Castleman's River, 659
564. Lockport, ... 661
565. Ligonier, ... 662
566. Indian Creek, ... 664
567. Contact of Mesozoic and older Palæozoic Rocks at Monroe, 681
568. A Chasm in the Auroral Limestone, south foot of Neversink Mountain, Reading, filled with Upper Mesozoic Conglomerate, ... 682
569, ... 691
570, ... 693
571. Leighton's Iron Mine, Warwick, Chester County, . 708
572. Ore-ground at St Mary's, Old Warwick Pits, Chester County, ... 708
573, ... 718
574. Section across Kittatinny Valley, from Blue Mountain to Cornwall, 15 miles, ... 718
575. Map of the Cornwall Ore Hills, Lebanon County, . 719
576. Section through Cornwall Iron Mines, Lebanon County, along line *a b*, ... 719
577. Big Mine Ore Hill, Cornwall Iron Mines, Lebanon County, 719
578. Ore Quarry, east base of Big Hill, Cornwall, Lebanon County, ... 720
579. Guth Mine, ... 723
580. Kern and Albright's and Hoffman's Mines, near Siegerville, ... 723
581, ... 724
582. Ore Pits, ... 726
583. Surgent Fossiliferous Ore Group, Hollidaysburg, Blair County, ... 730
584. Synoptic Diagram of the European Formations, . 742
585. 1. Conformable Continuous Sequence; 2. Conformable Interrupted Sequence; 3. Unconformable Continuous Sequence; 4. Unconformable Interrupted Sequence, 777
586. Hasbruck's Quarry, Rondout, showing unconformity of Pre-meridian upon Matinal strata, ... 785
587. Oblique Deposition by Strewing, ... 812
588. Oblique Stratification from Suspension, . . . 813
589. Scolithus linearis, ... 816
590. Paradoxides spinosus, from a quarry in Quincy, Massachusetts, one-third its natural size, ... 816
591. Leptæna incrassata, ... 817
592. Atrypa plicifera, ... 817
593. Murchisonia bicincta, ... 817
594. Raphistoma staminea, ... 817
595. Maclurea magna, ... 817
596. Orthoceras multicameratum, ... 817
597. Chætetes lycoperdon, ... 818
598. Strictopora acuta, ... 818
599. Leptæna sericea, ... 818
600. Leptæna alternata, ... 818
601. Orthis testudinaria, ... 818
602. Orthis pectenella. (N. S.?) 818
603. Orbicula. (N. S.?) 818
604. Lingula curta, ... 818
605. Ambonychia bellastriata, ... 819
606. Pleurotomaria subconica, ... 819
607. Bellerophon bilobatus, ... 819
608. Orthoceras vertebrale, ... 819
609. Conularia Trentonensis, ... 819
610. Isotelus gigas, ... 819
611. Trinucleus concentricus, ... 820
612. Graptolithus pristis, ... 820
613. Calymene Beckii, ... 820
614. Agnostos lobatus (1 and 3 natural size, 2 and 4 enlarged), ... 820
615. Lingula quadrata, ... 820
616. Delthyris lynx, ... 820
617. Avicula insueta, ... 820
618. Modiolopsus modiolaris, ... 820
619. Cyrtolites ornatus, ... 820
620. Pleurotomaria bilix, ... 820
621. Ormoceras crebriseptum, ... 821
622. Glyptocrinus decadactylus, ... 821
623. Arthrophycus Harlani, ... 821
624. Bucania trilobatus, ... 822
625. Buthotrephis gracilis (?), ... 822
626. Rusophycus bilobatus, ... 822
627. Cornulites, ... 823
628. Avicula subplana, ... 823
629. Lingula oblonga, ... 823
630. Leptæna depressa, ... 823
631. Leptæna patenta, ... 823
632. Atrypa congesta, ... 823
633. Atrypa reticularis, ... 823
634. Atrypa intermedia, ... 823
635. Orthus elegantula, ... 823
636. Orthoceras imbricatum, ... 823
637. Calymene Clintoni, ... 823
638. Tentaculites ornatus, ... 824
639. Onchus (?) Deweii, ... 824
640. Atrypa peculiaris, ... 825
641. Atrypa, ... 825
642. Atrypa lævis, ... 825
643. Delthyris macropleura, ... 825
644. Spirifer sulcatis, ... 825
645. Rhynconella nobilis, ... 825
646. Pentamerus galeatus, ... 825
647. Platyostoma, ... 825
648. Strophomena punctulifera, ... 825
649. Meganteris oviodes, ... 826
650. Spirifer Arenosa, ... 826
651. Atrypa unguiformis, ... 826
652. Atrypa limitaris, ... 826
653. Orbicula minuta, ... 826
654. Orthoceras subulatum, ... 826
655. Cyathophyllum turbinatum, ... 827
656. Fenestella? 827
657. Avicula decussata, ... 827
658. Modiola concentrica, ... 827
659. Avicula flabella, ... 827
660. Microdon bellastriata, ... 827
661. Orthonota undula, ... 827
662. Avicula, ... 827
663. Avicula, ... 827
664. Posidonia or Estheria, ... 827
665. Strophomena crenistria, ... 827
666. Strophomena demissa, ... 827
667. Spirifera spiriferoides, ... 828
668. Spirifer mucronata, ... 828
669. Delthyris medialis, ... 828
670. Delthyris congesta, ... 828
671. Atrypa aspera, ... 828
672. Tropidoleptus carinatus, ... 828
673. Delthyris granulifera, ... 828
674. Productus hirsutus, ... 828
675. Lepidodendron primævis, ... 828
676. Goniatites interruptus? 829
677. Lepidodendron, ... 829
678. Avicula damnoniensis, ... 829
679. Avicula, ... 829
680. Strophomena Chemungensis, ... 829
681. Atrypa hystrix, ... 829
682. Atrypa eximia, ... 829
683. Delthyris cuspidata, ... 829
684. Ponent Fern? 830
685, ... 831
686. Trail of a Mollusc? 832
687. Productus, ... 833

FIG. PAGE
688. Pentremites, ... 833
689. Avicula, ... 833
690. Nucula ? 833
691. Pleurotomaria, ... 833
692. Nautilus decoratus, ... 833
693. Lingula, ... 833
694. Spirifer of the Coal Strata, ... 833
695. Beyrichia Maccoyiana, ... 834
696. Beyrichia Pennsylvanica (different stages of growth), . 834
697. Leperditia ovata, ... 834
698. Leperditia Gibbera, Var. Scalaris, ... 834
699. Leperditia Pennsylvanica, ... 834
700. Kittatinny Mountain on the west side of the Delaware Water-Gap, ... 884
700a. Kittatinny Mountain on the east side of the Delaware Water-Gap, ... 884
701. Symmetrical Flexure, ... 888
702. Normal Flexure, ... 889
703. Folded Flexure, ... 890
704. Undulations in Scalent Variegated Shales and Sandstones on Pennsylvania Railroad, Juniata River, below Mifflintown, Juniata County, looking south-west, . 894
705. Undulations in Scalent Variegated Shales on Juniata River, below Lewistown, looking south-west, . 894
706. Generalised Section of the Appalachian Chain from north-west to south-east, through the Juniata District of Pennsylvania, ... 895
707. Delaware Water-Gap, ... 896
708. Upward Displacement of uninverted side of fractured anticlinal, ... 898
709. Upward Displacement of inverted side of fractured synclinal, ... 898
710. Upward Displacement of whole anticlinal flexure; fault in the inverted side, ... 898
711. Downward Displacement of uninverted side of fractured anticlinal, ... 898
712. Downward Displacement of inverted side of fractured synclinal, ... 898
713. Downward Displacement of whole anticlinal flexure; fault in the inverted side, ... 898
714. Generalised Section of the Alps, displaying the Dipping of the Folds of the Strata on both Sides in towards the Igneous Axis, ... 902
715. Fan-like arrangement of Cleavage at an Anticlinal Axis, 903
716. Beds of Red Shale with Cleavage alternating with beds of Sandstone without Cleavage; Cleavage curving towards parallelism with the bedding at its boundaries. Section near Ashland, Pennsylvania, ... 903
717. Dykes expanding upwards in Anticlinals and downwards in Synclinals, ... 906
718. Cleavage in Red Shale, caused by a Trap-dyke parallel to its walls, near New Hope, Pennsylvania, . . 912
719. Cleavage superinduced by a Trap-dyke in Red Argillaceous Sandstone of Jurassic (?) age, west of Gettysburg, Pennsylvania, ... 912
720. Plateau with simple Escarpment, Shelf of Niagara, . 918
721. Plateau with complex Escarpment, Mountain Ridge, New York, ... 918
722. Terraced Plains, ... 918
723. Plateau with Terraced Escarpment, Pokono Mountain, 918
724. Plateau with upper Escarpment terraced, Alleghany Mountain, Pennsylvania, ... 918
725. Plateau with lower escarped Slope terraced, Catskill Mountain, ... 919
726. Ridged and grooved Plain, ... 919
727. Ridged and grooved Table-land, ... 919
728. Single-crested Monoclinal Ridge, ... 920
729. Double-crested Monoclinal Ridge, ... 920
730. Double Monoclinal Ridge, with terrace on the back, . 920
731. Double Monoclinal Ridge, with terrace on the front, . 920
732. Complex Monoclinal Ridge, ... 920
733. Complex Monoclinal Ridge, ... 920
734. Monoclinal Ridge, a Profile of the Kittatinny Mountain, near the Susquehanna (strata inverted), . . 920
735. Simple Monoclinal Valley, ... 921
736. Double Monoclinal Valley, ... 921
737. Complex Monoclinal Valley, ... 921
738. Single-crested Anticlinal Ridge, ... 921
739. Triple-crested Anticlinal Ridge, ... 921
740. Double-crested Anticlinal Ridge, or simple Valley of Elevation, ... 922
741. Complex Valley of Elevation, ... 922
742. Complex Valley of Elevation, with central Anticlinal Ridge, ... 923
743. Simple Synclinal Ridge, flexure close, . . . 926
744. Simple Synclinal Ridge, flexure open, ... 926
745. Synclinal Ridge in Synclinal Valley, or Triple Synclinal Ridge, ... 926
746. Triple Synclinal Ridge or Terrace, ... 926
747. Simple Synclinal Valley or Basin, ... 926
748. Complex Synclinal Mountain, ... 927
749. Complex Synclinal Valley, ... 927
750. Mounds and Hollows in the Drift, ... 928
751. Benched Outcrop of Coal Strata, ... 929
752. Terraced Hill-sides, ... 929
753. Level Ravine in Monoclinal Ridge viewed from above, perpendicular to strike, ... 929
754. Level Ravine in Monoclinal Ridge, oblique to strike, . 930
755. Sloping Ravine, descending in the direction of the dip more *rapidly* than the strata do, towards the observer, 930
756. Sloping Ravine, descending in the direction of the dip more *gently* than the Strata do, towards the observer, 930
757. Sloping Ravines cutting Terraces on the dipward side of a Ridge, ... 931
758. Sloping Ravine descending against the Dip, . . 931
759. Gap in a Simple Monoclinal Ridge, ... 932
760. Gaps intersecting Monoclinal Ridges, ... 932
761. Gap in an Anticlinal Ridge of hard strata, . . 933
762. Gap or Oval Pass in an Anticlinal Ridge, the lower stratum being soft, ... 933
763. Gap in an Anticlinal Ridge. Complex variety arising from two hard and two soft strata, ... 935
764. Gap in Anticlinal Ridge. Complex variety produced by three soft and two hard strata, ... 935
765. Profile of a Synclinal Knob, ... 938
766. Diluvial Scratches deflected up and along the South Mountain Barrier of the Wyoming Valley, . . 941
767. Section of Strata north-west side of Laurel Hill, Cheat River, Virginia, ... 957
768. Upper Coal-measures, Holloway's Borings, Henderson County, Kentucky. From D. D. Owen, . . 962
769. Lower Coal-measures of Kentucky. From D. D. Owen, 962
770. Overturned Outcrops of Coal-Seams, ... 1008
771. Mouth of Drift in Horizontal Strata, ... 1010
772. Montelius's Open Cut, Mill Creek, Mine Hill Valley, . 1010
773. Part of Underground Workings of the Primrose Coal-seam at Neill's Colliery on Silver Creek, from Plan by G. K. Smith, Mining Engineer of Pottsville, . 1011
774, ... 1023
775. Section through Penn's Valley and east end of Kishacoquillas Valley, showing Terraced Ridges, . . 1023
776. Section from Gap in Town Hill to Warrior Ridge, along the Rainsburg Road, ... 1024
777. Section from Tussey Mountain, near Alexandria, to Jack's Narrows of Juniata, 17 miles, . . . 1024
778. Section from the neighbourhood of Tamaqua, across Locust Valley and the west ends of the Beaver Meadow and Bucks Mountain Basins, ... 1024

GEOLOGY OF PENNSYLVANIA.

BOOK VIII.

EIGHTH PALÆOZOIC DISTRICT, OR ANTHRACITE COAL-BASINS, & ENCIRCLING BELTS OF THE OLDER CARBONIFEROUS ROCKS.

INTRODUCTION.

POSITION OF THE ANTHRACITE BASINS IN THE MOUNTAIN-CHAIN; LIMITS AND SUB-DIVISIONS OF THE DISTRICT; STRATA, AND THEIR RELATIONS TO THE TOPOGRAPHY; CLASSIFICATION OF THE COAL-MEASURES.

Having in the several foregoing divisions of this work described all the Palæozoic strata within the State, from the base of the system to the top of the Ponent series, I shall proceed to set before the reader the geological structure and contents of the very important district which embraces the Anthracite Coal-fields. To acquire a full and clear conception of the nature, distribution, and positions of the strata, it is essential we should take a comprehensive preliminary survey of the region, see why it occupies the place it does, learn its boundaries and subdivisions, and trace its formations under their variations of composition and thickness.

GENERAL STRUCTURE OF THE MOUNTAIN-CHAIN IN ITS RELATIONS TO THE ANTHRACITE BASINS.

The whole region from the Southern part of the Atlantic Slope to the Northern border of the State may be viewed in a broad light, as composed of two great systems of crust-undulations: one group entering the State from the N.E., and expiring between the Schuylkill and the Susquehanna in the Southern half of the State, and between the waters of Pine Creek and those of the Western streams in the Northern; the other occupying the country W. of the main Susquehanna and its W. branch, and expiring North-eastward, within the same districts as the first—the two sets, indeed, interlocking at their extremities.

The waves of the first or North-eastern belt are for the most part comparatively broad and gentle flexures, and except in the local group of the South Mountains east of the Schuylkill, they do not lift relatively deep-seated formations to the surface. The other, or South-western set, on the contrary, elevate at intervals the lower Palæozoic rocks throughout the entire breadth of the middle zone of the chain, from the Cumberland Valley to the Bald Eagle Mountain, the corrugation of the crust being in much steeper waves in this quarter than in the other. In the district S. and S.E. of the Alleghany Mountain, the subsidence of the two systems of undulations here mentioned, towards each other, causes the whole tract of country lying between them to contain a greater depth of the stratified rocks than either of the more corrugated districts themselves possess. The general erosive action of the oceanic waters, disturbed by the billowy oscillations of the crust and the permanent uprising of these belts of anticlinal flexures, has planed down to a nearly common level all portions of the uplifted zone, so that that division or segment of the chain which received the least amount of upward movement—the district, namely, between the sinking ends of the two systems of anticlinal waves—was the most protected from denudation, and retains the largest proportion of the strata originally deposited on the highest formations. It is in virtue of these conditions, namely, a less vertical upheaval and a less depth of denudation, that the mountain-chain here contains between the two regions of more prominent anticlinal flexures a broad tract of parallel synclinal basins. Thus it is, that low on the Atlantic Slope there exists in this position the deep synclinal trough of the Montgomery and Chester Valley; that a little further to the N.W. there lies between the terminations of the North-eastern and South-western anticlinals, or those respectively of the South Mountains east of the Schuylkill, and the South Mountains west of the Susquehanna, the broad plain of limestone and red shale in Lancaster, and the counties adjoining; and that, thirdly, within the Appalachians proper there occur the deep troughs of anthracite coal, in which the highest of all the Palæozoic formations have escaped denudation. A little attention to the topographical and geological features of this middle or synclinal region, as presented on the Map, will make it apparent that all the chief anticlinal flexures of this quarter are simply the terminal portions of the great waves of the two anticlinal zones here meeting and passing each other. Only upon this comprehensive view can we understand the curious laws which regulate the distribution of the lesser or secondary undulations which corrugate every part of the coal-field, or comprehend satisfactorily the source and nature of the dislocations which traverse it in so many places, and with such seeming want of regularity.

Looking at the order of distribution of the chief or primary flexures which make up each of the two great systems between the Atlantic Slope and the Alleghany Mountain, we discover a very interesting feature of symmetry in each. Those of the North-eastern system, or the set of flexures entering the State from New Jersey and New York, and expiring towards the S.W., are beautifully arranged in echelon in greater and lesser groups, each group penetrating to a less distance Westward than that next S. of it; so that the whole belt from Lancaster County to the Eastern Middle Coal-fields ends nearly on one meridian, a line or narrow belt not rigidly straight trending a little E. of N. through Lancaster and Pottsville. The reader will discern at a glance this relation of the flexures of the strata, if, with the Map before him, he will cast his eye through the Western points of the Mine Hill, Welch Mountain, South Mountain at Reading, the spurs of the Blue Mountain between Port Clinton and Orwigsburg, those of the Sharp Mountain at Middleport, of the Nesquehoning and Broad mountains, and those of the table-land of the Middle

Coal-field west of the Lehigh. Nor does this retreating of the anticlinals, as we proceed Northward, cease at the Lehigh, for it is clearly discernible in the curious echelon arrangement of the saddles, entering the S.E. side of the Northern anthracite fields from the Eastward. There is, in keeping with this curious symmetry—into which, indeed, it enters as one element—an approximate equality of interval between the larger groups of undulations. From the Welch Mountain, or gneissic area E. of it, to the Wyoming coal-field inclusive, we may count five great belts of flexures—namely, those of the Welch Mountain, the South Mountain, the Blue Mountain, the Lehigh and the Lackawanna coal-fields. These are not strictly equidistant, but lie at slightly wider and wider intervals as we cross them Northward—a feature in strict harmony with the very general law of the crust-undulations of the Appalachian Chain, whether group is compared with group in an extensive zone, or individual flexure with flexure in a single belt.

Turning to the South-western system of undulations, or those which originate beyond the Susquehanna, and expire Eastward against or past the ends of the North-eastern system between the Susquehanna and the Schuylkill and Lehigh, we observe a symmetry in the relative arrangement of the chief waves or groups of waves which is even more remarkable. In this instance, as in the other, they are disposed in echelon, but the more North-western, in place of retreating, protrude past their neighbours on their S.E., outflanking them with a beautiful regularity. But in place of terminating on a Meridian, or line running N. and S., the more Northern flexures overpass the Southern ones so much, that a line connecting the extremities of the whole system—necessarily not a very straight one—will have rather a N.N.E. and S.S.W. direction, than a N. and S. one. It is to this circumstance that we are to impute the singularly oblique disposition of the anthracite coal-basins, or the overrunning of the Northern, Eastward of the more Southern, a distribution which, viewed in its economical bearings, is of immense importance, since it renders the Northern coal-fields almost as accessible to the tide-waters of the Hudson as the Southern ones are to those of the Delaware and Chesapeake. But for this interesting distribution in echelon, the Wyoming or Lackawanna coal-field would have lain to the N.W. and not to the N.E. of the Pottsville and Mahanoy basins, and its rich stores of fuel would have been hemmed in by a much wider belt of mountains than that which now separates them from the great coal-consuming markets of New York and the Eastern States.

As in the case of the North-eastern flexures, these of the South-western system observe a beautifully regular gradation of expansion as we measure the breadth of the waves in their order Northward, but this dilatation appears to be very gradual. Starting with the South Mountains of Cumberland and Adams counties as one belt, and viewing the closely-folded flexures in the Matinal shales between Harrisburg and the Blue Mountain as another, and then adding as a single wave each of the five anticlinal belts penetrating Eastward between the Western ends of the coal-basins—namely, those of Armstrong, Mahantango, Roaring Creek, Wapwallopen, and Harvey's Lake valleys, we find the entire zone to include seven great undulations, or, more truly, seven compound groups of anticlinal flexures. If to these we further add, what legitimately belongs to them, the great anticlinal wave whose crest or axis ranges along the N.W. margin of Nittany Valley, and through Nippenose Valley, and the spur of the Bald Eagle Mountain, we shall find the total number of primary flexures at the Susquehanna to be eight, excluding those N.W. of the Alleghany Mountain. If the reader, wishing to compare the relative distances of these great belts of elevation of the strata, will, with the Geological Map

before him, measure their spaces with a pair of compasses anywhere between the primary geological sections Nos. VI. and VII.,—starting, say, at the Eastern end of the South Mountains,—he will notice a slight increase of interval until he reaches the last space, or that between the Brush Valley axis and the axis of Nittany Valley, where an extensive dislocation along the latter, with overturn of the N.W. leg of the wave, causes the interval to be abnormally reduced.

In the South-western portion of the Appalachian Chain which fills the interval between the Susquehanna and the Potomac rivers, the grouping of the flexures is essentially different from that which I have just outlined. Towards the S.E. or E. we have still the great anticlinal belt of the South Mountains, or the Blue Ridge, exposing numerous compressed waves of the Primal rocks. West of this, on the opposite side of the Appalachian Valley, is the next main compound anticlinal tract, comprehending Path Valley and M^c^Connell's Cove, and lifting to the day the Auroral limestone. Beyond this there lies a broad deep basin of all the higher Palæozoic rocks up to the Coal-measures inclusive, and W. of it, again, a third wide complex anticlinal belt again elevating to the day the Auroral rocks in Morrison's, Friends', and Milliken's coves. Thus between the Juniata River and the State of Maryland the flexures of the Appalachian Chain, roughly grouped, arrange themselves in three broad anticlinal tracts—those of the South Mountains, of Path Valley, and of Morrison's Cove respectively; and three equally wide and complex synclinal ones—those of the Cumberland Valley, of Broad-Top Mountain, and of the Cumberland coal-basin.

Having thus reviewed the general structural features of the mountain-chain, and shown how its great anthracite basins have come to be where they are, and why they are so far detached from the main coal-field of the country, while elsewhere along the chain, except in the Broad-Top Mountain, all the Coal-measures have been swept away, I shall proceed to give a summary sketch of the coal region itself, preliminary to a systematic and minute description of each of the several basins and its contents.

GENERAL LIMITS OF THE ANTHRACITE DISTRICT.

The zone of carboniferous rocks embracing the anthracite basins of Pennsylvania is a long irregular tract of a rudely-rhombic shape, stretching from the W. edge of Wayne County South-westward to the E. corner of Perry, bounded on the N. by the Northern base of the Wyoming and Shickshinny Mountain, on the S. by the Orwigsburg Valley, on the E. by the Moosic Mountain and upper waters of the Lehigh, and on the W. by the Susquehanna. It may be viewed as a rolling plateau somewhat elevated above the surrounding valleys, and containing many slender parallel mountain-ridges, some broad included table-lands, and numerous long narrow valleys. Its Western margin is very deeply indented by four large anticlinal coves of the Ponent and Vergent formations, subdividing this side of the tract into five synclinal belts of basins, each including an independent coal-field. Its Eastern border is more vaguely defined, the lower carboniferous rocks, or Vergent and Umbral strata, lifting themselves gradually to the N.E. beyond the Lehigh, and thinning off there by a very irregular denudation in the table-land of Monroe and Pike counties. Assigning as its precise geological boundary the outer edge or lowest stratum of the Vespertine sandstone, this carboniferous district may be somewhat accurately defined as follows: Its S. or S.E. border ranges along the

outer crest of the Mahoning or Second Mountain from the Knob of the Kettle, E. of the Lehigh to the Knob of the Cove Mountain, W. of the Schuylkill. Thence along the N. brow of Peter's Mountain to Short Mountain at the head of Powell's Valley, and through the outer summit of Short Mountain, round the head of Armstrong Valley, to the S. brow of Berry's Mountain, and along the latter to the Knob of Buffalo Mountain, near the Juniata. Pursuing thence an E. course, it stretches along the N. brow and slope of Mahantango to its junction with Line Mountain, doubles abruptly to the W., and follows the latter to the Knob of Mahanoy Mountain at the Susquehanna, where, deflecting abruptly to the E. again, it takes the slope of Mahanoy Mountain, and its extension, Little Mountain, to the head of Roaring Creek Valley. Here the boundary turns W., winds along the W. brow of the Catawissa Mountain and its spurs to the N. slope of the Nescopeck Mountain, which it follows Eastward to the head of the Wapwallopen Valley. There, after two or three windings, the line takes the Southern slope of the Pond Mountain to its junction with the Shickshinny Mountain near Fishing Creek, where, bending sharply towards the E., it ranges along the latter high on its N. flank to the North Branch of the Susquehanna, beyond which, gradually deflecting more and more towards the N., and receding from the mountain, it approaches the N. point of the Lackawanna coal-basin. Curving with a wide sweep round the head of this coal-field, the boundary, always the limit between the Ponent and Vespertine strata, becomes irregular and difficult to define; but we shall arbitrarily assume a line drawn from the head-waters of the North Branch of the Wallenpaupack to Beaver Lake of the Lehigh River for part of the E. limit of the tract, the remainder being the channel of the Lehigh River from Beaver Lake to the Kettle Mountain, near which we started.

The very tortuous margin here traced encloses an irregular parallelogram of mountains and valleys, measuring, in superficial area, about 1668 square miles, the length of which from N.E. to S.W. is about 100 miles; and its greatest transverse breadth, through Mauch Chunk and Nanticoke, is not less than 30 miles. The coal-formation proper constitutes but a small part of this large area of the carboniferous rocks. It will be shown hereafter to comprise less than 300 square miles.

Natural leading Subdivisions of the District.—The district of carboniferous strata of Eastern Pennsylvania, defined in the foregoing brief description, may be subdivided naturally into three tracts, a Southern, Middle, and Northern. The Southern is separated from the Middle on the W. by the anticlinal belt of Ponent and Vergent strata, occupying Mahantango Valley, and on the E. by the much more slender anticlinal valley of Little Bear Creek, between Kettle Mountain and the Pokono. The Middle is separated from the Northern by the long regular anticlinal valley watered by the Wapwallopen Creek and the Berwick Reach of the Susquehanna. Each of these three tracts is a complex synclinal basin, enclosed within a mountain-rim of Vespertine sandstone, except where they coalesce over the anticlinals which only partially insulate them; each is undulated into numerous anticlinal and synclinal flexures, the axes of which traverse it longitudinally with a slight obliquity, and each contains, as its central uppermost formation, a large area of the anthracite Coal-measures. The S. tract encloses the Schuylkill or Pottsville coal-basin, including both its W. spurs and also the Broad Mountain; the middle tract, the Shamokin and Mahanoy coal-basins with their branches, and the group of basins lying between the Lehigh and the Catawissa; and the N. tract, the basin of the Lacka-

wanna and Susquehanna, or the Wyoming coal-field; and each of these undulated troughs of the coal strata, rimmed round by a mountain-barrier of the coarse and hard lower coal rocks, is further encircled and shut in by a deep valley of the soft Umbral red shales, and by a second mountain-barrier outside of this, composed of the hard Vespertine sandstones and conglomerates. The only quarter where the Coal-measures are not thus engirt by a double rim of mountains is the N.E. half or Lackawanna division of the N. basin. There the Umbral formation being abnormally thin, the two hard projecting strata—the coal conglomerate and the Vespertine sandstone—lie unusually near to each other, and generally form but one broad mountain-ridge, with a bench or terrace of the intermediate Umbral shale.

It is an interesting and important feature in the structure of this carboniferous district, that all its subdivisions, as well its primary as its lesser, down to its most trivial ones, are determined by its anticlinal flexures and the denudation or cutting away of the strata over them; and the absence of any symmetry between the E. and the W. terminations and spurs of the coal-fields, results simply from the fact that these flexures do not consist of a single system of waves running through and through the region, but—as intimated in a former Chapter—of two sets overlapping each other, and expiring within it. A very little study of the Map will render this perfectly obvious, and will show, moreover, how many of the interior features of the coal-basins, even those of insignificant magnitude, are the consequences of flexures of primary importance in the regions exterior to this district. A detailed description of the flexures of the strata is reserved for the future Chapters treating of the special coal-basins in their minuter features, but it is expedient meanwhile to notice the effects of two of the chief anticlinals which enter the region from the E. and W. Only one great flexure from the E., or from beyond the Lehigh, seems to penetrate the district far towards the centre. This is the axis of the Nesquehoning Mountain or of Little Bear Creek. Originating in the Vergent rocks S. of the Pokono, and then gradually declining W., it is saddled by Ponent strata in the valley of Little Bear Creek as far as the Lehigh. Beyond this river the flexure is a broad flat wave, spanning the whole interval from the S. to the Beaver Meadow Basin, exposing in its centre the Vespertine rocks throughout the breadth of the Nesquehoning Mountain. Further W. the Umbral red shales occupy the back of this anticlinal in a wide valley at the sources of the Little Schuylkill, and continuing to subside, it expires under the coal conglomerate of the Broad Mountain. The main axis of this compound wave extends through the W. point of Nesquehoning Mountain, and through the Southern cove in Broad Mountain, at the source of Locust Creek, and the red-shale hollow in Broad Mountain E. of Mill Creek. Other lesser flexures, subordinate to the same broad wave, entering the region from the Pokono Mountain or beyond it, and ranging through the Nesquehoning Mountain, die out in the Broad Mountain north of the principal one. It is this group of anticlinals which insulates the E. end of the Southern from the E. portion of the middle coal-field by lifting the red shale to the surface, and further W. the conglomerate in the Broad Mountain.

Nearly opposite to the wide anticlinal belt just described, a still more prominent one penetrates the region from the W. This latter great wave, also a compound flexure, after elevating the middle Palæozoic formations in the Mahantango Valley, rapidly sinks towards the E., and enters the carboniferous rocks at the junction of the Line and Mahantango mountains. From this point E. to the head of the Little Mahanoy it is arched by the Umbral red shale, and throughout this distance insulates the Broad Mountain from the Mahanoy coal-basin. Sub-

siding in the conglomerate near the N. edge of the Broad Mountain, it separates the Coal-measures of that table-land from those of the middle coal-field Northward. It thus appears that the Nesquehoning and Mahantango anticlinals pass or overleap each other in the Broad Mountain; and it is to this circumstance, and to their being themselves compound undulations of the strata, that the Broad Mountain contains several subordinate flat saddles of the conglomerate and intermediate shallow basins of the Coal-measures.

The middle division of the district comprises, as we have seen, all that area which lies between the Nesquehoning Mountain and Mahantango Valley on the one side, and the valley of the Wapwallopen and N. branch of Susquehanna on the other; but the interior plateaus and basins of this region, consisting of the true coal-rocks, are separated into two nearly independent groups by intermediate valleys of red shale, especially by that which is drained by the head-waters of the Catawissa Creek, and it is expedient to bestow separate designations upon the two portions of the coal-field thus divided. I propose, therefore, to call the Mahanoy and Shamokin basins, and their branches, the Western Middle Coal-field; and all the elevated area of the coal conglomerate and Coal-measures situated N. of the Quakake Valley, N. and E. of the valley of the Catawissa, and S. of the valley of the Nescopeck, the Eastern Middle Coal-field.

The carboniferous district of Eastern Pennsylvania contains centrally within it, therefore, four great coal-fields or groups of coal-basins.

1st. The Southern, or Pottsville coal-field.

2d. The Western-Middle, or Mahanoy and Shamokin coal-field.

3d. The Eastern-Middle, or Upper Lehigh coal-field.

4th. The Northern, or Wyoming and Lackawanna coal-field.

Indeed, ample mention has already been made in Chapter III. of the Introductory Book, Part II., of their mineral nature, and their measured thicknesses around and within both the anthracitic and bituminous coal-fields of the State, enabling any one to deduce their characters and dimensions for intermediate localities not enumerated, and affording all the requisite data for any scientific conclusions that the present state of geology can suggest concerning the quarters whence their materials were derived, and the physical conditions under which these were deposited, and supplying, moreover, all the elements of a practical or technological interest. But full as this synoptic statement is, it seems expedient to introduce here a special description of the Vespertine and Umbral rocks of the anthracite country.

DESCRIPTION OF THE STRATA.

In the carboniferous district embracing the anthracite fields, and, indeed, in the much more extensive region of the bituminous Coal-measures, the only rocks at or near the surface, besides those of the coal formation itself, are the Vespertine sandstones and the Umbral red shales. A careful comparison of the organic remains of the three formations has demonstrated that they are equivalent or parallel deposits to the three great subdivisions of the carboniferous system of Europe. The Vespertine rocks correspond apparently to the European lowest carboniferous formation of the yellow sandstones of Ireland; the Umbral series is the near equivalent of the carboniferous limestone and its associated strata; and the anthracite coal-measures seem strictly on the horizon of the great coal-formation of England, France, and Belgium. It is proper, therefore, that the three series should be grouped together, and described in the

same division of this work, and the expediency of this treatment is confirmed by their close geographical connection.

Vespertine Series around the Anthracite Basins.—Both this formation and the Umbral have received a general description in the Introductory Book to Part II., where not only their composition, but their distribution and changes of type and thickness, have been systematically stated.

In its S.E. development, or surrounding the S. coal-field, the Vespertine formation consists, as already described, of grey and yellowish sandstones, with beds of coarse silicious conglomerate, and of dark-blue and olive-coloured slates. Like nearly all the coarser mechanical strata of the Appalachian Chain, it is both thickest and coarsest towards the S.E. or E., and it shows a marked gradation in these respects between each of its successive outcrops. Thus, while its first outcrop displays at Pottsville a thickness of 1800 feet, and at the Susquehanna of 2000 feet, its outcrop in the Nescopeck Mountain shows a reduction of dimensions to 1100 feet; and still further N., in the mountains enclosing the Wyoming coal-field, a further reduction to only 500 or 600 feet. In accordance with this change of dimensions, it undergoes a corresponding alteration from the coarse type we have assigned it in its Southern outcrops, to that of an argillaceous greenish-grey sandstone, and interstratified reddish olive-coloured shales, in its Northern.

At Mauch Chunk, where its total thickness is about 1300 feet, the first or lowest 500 feet consist, in ascending order, of

Olive-coloured shale, ...	66 feet.
White silicious sandstone, ...	60 „
Fine-grained grey sandstone with large fracture, ...	374 „

The middle and upper divisions are here composed of alternations of coarse conglomerates, and grey and bluish coarse and fine-grained sandstones, embracing thin beds of olive and black slate. At the base of the formation there occurs a thick alternating group of beds of grey sandstone, some of them pebbly, and beds of argillaceous red sandstone and red shale, identical with the Ponent series. This is a passage-group between the Ponent and Vespertine, not referable to either formation exclusively. The few obscure organic remains discovered in it are stems of *Lepidodendra* imbedded in the grey sandstones, relating these beds to the Vespertine series. This transition-group has an average thickness of 600 or 700 feet.

At Pottsville this intermediate mass consists, in the ascending order, of the following beds:

1. Grey sandstone with a little conglomerate, surmounted by a dull reddish sandstone, 72 feet thick.

2. Greenish-grey sandstone and olive-coloured micaceous sandstone, including some beds of conglomerate, and succeeded by hard red sandstone, and this again by softer red argillaceous sandstone, 56 feet.

3. A hard dull-red sandstone, a speckled grey sandstone, and layers of red shale, 62 feet.

4. Argillaceous sandstone conglomerate, composed of slate and sandstone pebbles, and a hard red sandstone imbedding pebbles of quartz and slate, 197 feet.

5. A coarse grey sandstone, 120 feet.

6. Yellowish sandstone, with pebbles of slate, coarse grey sandstone, and a dull-red sandstone, 180 feet.

The total thickness of the group is 687 feet.

On the Susquehanna this alternating series, composed of very similar materials, has a thickness of about 525 feet.

The Vespertine conglomerate includes at Pottsville the following subdivisions in the ascending order :—

1. Coarse compact sandstones, and a brownish-red sandstone, 196 feet thick.
2. Speckled grey sandstone, olive-coloured micaceous sandstone, and compact purplish micaceous sandstone, 213 feet.
3. Coarse grey sandstone, with a little conglomerate, 240 feet.
4. Fine and coarse conglomerate, and hard compact greenish-grey sandstone, 162 feet.
5. A coarse hard yellowish and micaceous sandstone, with some conglomerate, 163 feet.
6. Coarse and fine conglomerate, with hard coarse grey sandstone, 109 feet.
7. Coarse grey micaceous sandstones and coarse conglomerates alternating, 292 feet.
8. Bluish-black micaceous slate 22 feet.
9. A coarse grey sandstone, succeeded by a very coarse harder variety, and this surmounted by a conglomerate of rather small quartz pebbles, 68 feet.
10. Coarse sandstone and conglomerate, 296 feet.
11. Hard greenish-grey sandstone, overlaid by coarse grey micaceous sandstone and beds of silicious conglomerate, 32 feet.
12. Grey sandstone and fine-grained conglomerate, 25 feet.

The last-described or upper beds of the formation, are at the N. foot of the Second Mountain, and the alternating series beneath commences a little below the bridge over the Schuylkill.

Leaving the S. outcrop of the Vespertine conglomerate, and advancing N.W. across the anthracite basins, we observe that the formation maintains very nearly the aspect and composition which it has in the Mahoning or Second Mountain, the most important change being a progressive declension in thickness and a gradual reduction in the coarseness of the conglomerates and sandstones, and an increased proportion of argillaceous matter. The same modifications are apparent in the intermediate group of strata which connect this formation with the Ponent series below it. In the Nescopeck and Shickshinny mountains these possess a thickness of less than 400 feet, and include fewer beds of coarse sandstone and conglomerate.

Umbral Red Shale around the Anthracite Basins.—This group of strata, occupying the immediate place in the general series between the Vespertine sandstone and Seral or coal conglomerate, surrounds all the coal-basins, the chief part of the formation appearing in the deep and regular valley immediately outside of the conglomerate which bounds the Coal-measures. The lower beds rest against the foot and on the lower slope of the ridges composed of the Vespertine conglomerate, and the upper strata dip beneath the Seral conglomerate high on the flank of each ridge of that formation. Throughout the Anthracite district the whole red-shale formation is remarkable for great sameness of character in its different parts, and for little variation, except in point of thickness, in the different belts along which it is exposed. In lithological composition it bears a very close general resemblance to the main body of the Ponent red shales and sandstones. Neither stratum is characterised by the presence of more than a very few organic remains. These, where they are met with, will readily serve to distinguish the two formations, the fossils of the Ponent series being for the most part bivalve shells and Encrini,

while the few forms found in the Umbral red shales belong almost exclusively to plants, but not to species or even genera identical with those of the Coal-measures.

The Umbral red shale consists, throughout its S.E. and middle belts, of very argillaceous red sandstones, alternating with red shales. In the vicinity of the Schuylkill these two rocks are associated in very nearly equal proportions, but as we advance Eastward upon the first or most Southern line of outcrop, the silicious or sandstone members predominate more and more. Everywhere the lower portion of the mass contains a preponderance of tough grey micaceous sandstone; the middle and upper divisions possess a larger share of soft red argillaceous beds, with occasional interstratified grey sandy shales, all alternating with red and grey argillaceous sandstones. This character extends to within a few hundred feet of the bottom of the overlying coarse strata of the Seral conglomerate, the intervening mass, referred for convenience to the Vespertine formations before us, consisting of an alternation of red shales identical with those of the Vespertine and coarse grey sandstone resembling the Seral group.

Of the red sandstone we may distinguish three varieties, differing in colour and hardness—1st, A florid red rock, rather soft; 2d, A brownish-red rock, more common than the preceding; and, 3d, A dull or greyish red, the hardest of the three. Many of the sandstone strata are delicately subdivided by alternate bands of different shades of colour, imparting to the smoothed or dressed surfaces a pleasing aspect. Those varieties which are not too argillaceous to withstand the attacks of weather, and are possessed of the softer and more neutral shales of brown and grey, seem well adapted for the purposes of architecture, and the time cannot be distant when their suitableness and beauty will cause them to be chosen in many places as preferable to common brick for buildings. Some of the grey silicious sandstones of the middle and inferior parts of the formation, though less attractive in their tints, are perhaps better fitted for certain architectural uses, being of a more durable composition, and yet susceptible of being readily shaped.

The more argillaceous varieties of the red shale frequently contain a small proportion of the carbonate of lime, and in a few localities there are even one or two thin bands of a very argillaceous limestone, not pure enough, however, for conversion into lime. In these layers of calcareous shale the greater part of the carbonate of lime is in the form of small oval concretions, seldom half an inch in length, looking like yellowish-white pebbles. By the dissolving action of the rain-water upon these calcareous concretions, the rock generally exhibits its external surface deeply pitted, the long-weathered portions wearing a singular worm-eaten aspect. Several such belts may be seen at Mount Carbon immediately S. of the hotel. These calcareous bands occur in the upper part of the formation, but in the middle and inferior parts of the mass such layers are more frequent and usually thicker. As many as twelve distinct beds are met with near Tamaqua. One of these is 6 feet thick, but the little nodules of limestone are rather thinly scattered; another is about 3 feet thick, and embraces the nodules in great abundance. The foregoing description is applicable more especially to all the Umbral red shale surrounding the Southern and central anthracite basins. The only quarter where there is any important addition to this type is in the belt encircling the Wyoming basin. There, though the red sandstone and red shale are still the prevailing rocks, they embrace much greenish silicious shale and grey calcareous sandstone. Towards the W. end of the basin these rocks are confined chiefly to the uppermost part of the

formation, but as the belt stretches N.E. they augment rapidly in quantity, and alternate with the red portions in the body of the formation.

Around the border of the Wyoming coal-basin the Vespertine rocks undergo a considerable change of composition and thickness, as may be seen by consulting the sections and vertical columns illustrating that region. I here present them as they occur at Solomon's Gap—a good central locality—that the reader may contrast them with their S. type, already given.

It is only in its S.W. outcrops—namely, in those around the bituminous coal-basins in Somerset, Westmoreland, and Fayette—that any continuous masses of limestone occur in the Umbral series, and even there this rock is of subordinate importance when compared with its enormous development in Virginia and in the Western States. In the anthracite district before us we have both the Vespertine and Umbral formations under their extreme Eastern or *littoral* types, and therefore the calcareous ingredient, a *marine* characteristic, is in its minimum development. Indeed, in the outcrops surrounding the anthracite basins, no genuine limestone presents itself in the Umbral red shale, and the great body of the formation is singularly destitute of calcareous matter in even a more diffused form.

Geographical Range of the Vespertine Sandstone and Umbral Red Shale.—The Vespertine and Umbral formations may be traced encircling all the anthracite basins in a nearly continuous but very winding belt, the Vespertine forming an unbroken mountain-girdle, and the Umbral a deep and narrow valley between it and a parallel and similar mountain-barrier, composed of the Seral conglomerate, which constitutes the immediate rims of the coal-basins. If we follow the line of outcrop of the Vespertine sandstone from it S.E. extremity, Westward round the coal-fields, we shall find it to coincide with the crest and inner flank of the Big Creek or Kettle Mountain, East of the Lehigh, and to form the entire anticlinal mass of the Nesquehoning or Broad Mountain East of the Little Schuylkill. Tracing it from the Lehigh, it forms the main or N. summit and the N. slope of the Second or Mahoning Mountain, with a steep N. dip the whole distance into Perry County, where it curves suddenly round towards the E. to enclose the beautiful red-shale valley called the "Cove." In this turn the Vespertine and Umbral rocks enclose the W. end of the Dauphin coal-basin. Recrossing the Susquehanna with a S. dip, it stretches E., forming Peter's Mountain, and folds round and over the great anticlinal of the Short Mountain, and, resuming a N. dip, becomes the ridge known as Berry's Mountain. It once more crosses and recrosses the Susquehanna, forming between it and the Juniata another synclinal cove of the Umbral red shale, usually called Hunter's Valley. In this synclinal trough the Vespertine and Umbral strata encircle the W. end of the Bear Valley, or Wiconisco coal-field. E. of the Susquehanna it forms the Mahantango Mountain, with a S.E. dip. The formation then bends suddenly W., folding over the great anticlinal of Mahantango Valley, and extends W. again in the Line Mountain as far as the Susquehanna, which, in this third W. bend, it does not cross. By another sudden flexure at the river, the formation sweeps again towards the E., and constitutes the long ridge called the Mahanoy and Little Mountain. This curve marks the termination of a third synclinal trough in the Vespertine and Umbral series encircling the W. end of the Shamokin coal-basin. A third great anticlinal, that of Roaring Creek Valley, causes the Vespertine conglomerate to change again its direction, and to fold round and bend W. in the ridge called the Catawissa Mountain. Near the town of Catawissa it forms, with the Nescopeck Mountain, a fourth synclinal trough, ending, as in each of the three preceding instances, in a bold synclinal

mountain-knob. Embraced within this last-mentioned trough of Vespertine and Umbral rocks are the small coal-fields of McAuley's Mountain and Black Creek. The Vespertine formation now ranges E. along the Nescopeck Mountain to the sources of the Lehigh. Here it flattens in its dip, and, expanding, overspreads—except near the anticlinal axis—the great flexure of Montour Ridge. Assuming a N. dip, it becomes the Wyoming or Moosic Mountain, the outer S.E. barrier of the Wyoming coal-basin. In the synclinal knob of the Shickshinny Mountain it makes a fifth sweep to the W., enclosing the W. end of the Wyoming coal-basin, and from this point it ranges N.E. in the Shickshinny and Lackawanna Ridge, forming the N.W. barrier of the coal-field until, this outcrop meeting the S.E. one, the two encircle the N. termination of the coal valley in Wayne County. Thus it appears that the Vespertine rocks of the anthracite region form by their W. outcrops five very symmetrical parallel synclinal basins, receding obliquely E. as they advance from S. to N. To the E. of the Lehigh the Vespertine sandstone expands in a wide tract in the general plateau of the Pokono Mountain, the W. part of which it entirely occupies. Uniting there with the more steeply-dipping belts of the Mahoning and Nesquehoning mountains on the S., and with that of the Nescopeck on the N., this broad outcrop completely encloses within it the E. extremities of all the Lehigh coal-basins, embracing between itself and them valleys of the Umbral red shale.

It is not necessary, after the account here given of the range of the Vespertine sandstone, to trace, with a corresponding minuteness, the outcrop of the Umbral red shale. It will suffice to state that, being the middle member of the three carboniferous formations, its monoclinal outcrops occur invariably between those of the underlying Vespertine sandstone, and those of the overlying coal conglomerate. The lower portion of the formation follows the Vespertine sandstone in all its windings and reaches, and usually outcrops high on the inner or synclinal slopes of the ridges formed of that rock. On the other hand, the upper part of the series conforms itself to the outcrop of the Seral conglomerate, ranging at a high level along the outer slopes of the mountain-barriers with which this rock rims in the several coal-basins, and penetrating all the anticlinal coves and nooks which insert themselves between the synclinal knobs or spurs that terminate the lesser troughs of the coal-formation. In a few localities, as at Mill Creek, on Broad Mountain, and in the Eastern Middle Coal-field, the Umbral red shale emerges to the day in slender oval anticlinal patches, encircled by the coal conglomerate, but not accompanied by any outcrop of the Vespertine sandstone.

The breadth and depth of the valley occupied by the easily-excavated Umbral red shale depend upon several circumstances,—the softness of the mass contrasted with the power of resisting watery erosion possessed by the two hard formations which enclose it, also its relative thickness, the steepness or flatness of its dip, and the presence or absence of subordinate flexures at its outcrop. Adjoining the Southern and Western Middle Coal-fields, it forms almost everywhere a monoclinal valley a mile or so in breadth between the crests of the confining ridges, but narrow in its bed, and steeply curving in its slopes. Surrounding the Wyoming coal-field, this valley is very narrow, and throughout the Northern half of the basin degenerates into little more than a bench or terrace, high on the interior slope of the encircling mountains.

It will be expedient to postpone any general view of the composition and geographical distribution of the Vespertine and Umbral strata connected with the bituminous coal region of the State, until we approach the systematic description of that great group of basins; but in the

following sketch of the coal-rocks the description will embrace those of the Western as well as those of the Eastern Coal-fields, for the sake of a clearer demonstration of their identity of origin, and their ancient geographical connection.

GENERAL VIEW OF THE SERAL SERIES OR COAL STRATA OF THE STATE.

The next group to be described consists of the *Coal Rocks*, the last or highest division of the great Appalachian system of strata succeeding immediately upon the Umbral series.

These strata constitute by far the most valuable portion of all the mineral deposits of Pennsylvania, and confer upon it an amount of accessible wealth surpassing that of any other commonwealth of the Confederacy, or that, indeed, of any equal country on the globe.

While they thus surpass in commercial value, acre for acre, every other group of strata, they also cover a far larger territory than any other formation within the State.

The truly gigantic scale upon which the coal-fields of Pennsylvania are modelled, gives to this portion of her geology peculiar claims to the attention, not merely of the geologist, but of the capitalist and the statesman.

By enabling the geologist to trace the same coal-seams and other strata through their modifications of type, this great horizontal expansion of the formation supplies him with important data for a sound theory of the physical conditions under which the coal originated.

To the capitalist it furnishes the assurance of an inexhaustible supply of the two varieties of raw material which must henceforth exceed all other substances in commercial and industrial influence, *Coal*, the greatest instrument of discovered mechanical or motive power; and *Iron*, the most variously useful and most indispensable of the inorganic bodies which the Creator has bestowed on man. To him it therefore exhibits a field for mining and manufacturing enterprise of almost unlimited scope and future growth.

To the statesman this display of the pre-eminence of Pennsylvania in mineral wealth, cannot but be viewed with the deepest interest, as it must appear to him by far the largest element in the problem of her future industrial, social, and political career.

The detailed examination of the coal-fields of the State engrossed, therefore, a very important share of the labours of the Geological Survey from its commencement to its recent close; and the facts collected, both special and general, are proportionably numerous. The better to enable the reader to grasp the extensive and complex body of descriptive details called for by the objects of the Survey, I shall commence my systematic account of the coal-formation of the State with a brief general outline of its composition and boundaries, and shall then recount more in detail the structure and contents of each particular coal-field or basin.

COMPOSITION OF THE COAL STRATA.

The coal-formation of Pennsylvania embraces a very great variety of strata, extending to nearly all the prevailing forms of sandstone, slate, limestone, and coal. These materials may be ranked under the following three classes of sedimentary deposits—namely, *Rocks of Mechanical, of Chemical, and of Organic or Vital origin.*

The coal strata of *Mechanical origin* are coarse heterogeneous conglomerates, chiefly of

quartzose grains and pebbles, silicious and argillaceous sandstones of all grades of coarseness and fineness of grain, and composed of sand and clay in all degrees of mixture; and a great variety of carbonaceous slates, clay-shales, and grey and purplish-coloured marls. The coarser and more silicious of these deposits prevail most in the inferior part of the series, where massive beds of conglomerate and silicious sandstone occur, both interstratified with the lower coal-beds and underneath them. It is only among the higher strata of the formation that the calcareous shales or variegated marls make their appearance, and the geographical range of these is restricted to the more central tracts of the great basin of the Western side of the State, or that of the Ohio River.

The *Chemically*-derived coal-rocks are limestone, chert, and iron ore. Some of the limestone-beds consist of nearly pure carbonate of lime, some contain also carbonate of magnesia, while others embrace, besides these two ingredients, a large admixture of argillaceous and silicious matter. All the limestones give proof of having been deposited in very tranquil water, for their sandy and argillaceous particles are very evenly incorporated, and almost impalpably fine. These beds of limestone exist only in the middle and higher parts of the series, and they are confined to the bituminous basins, having indeed but little development, except in the main Western one of the Alleghany River. In the anthracite measures, which are the most Eastern of all the coal strata, no limestone whatever appears. Many of the thicker of the Western calcareous coal strata consist of alternating layers of limestone and soft marly shale.

Chert occurs in two or three positions below the middle part of the series, in continuous beds of very considerable horizontal area, but only in the bituminous basins, and chiefly in the main Western one. One of these masses of chert is, for the most part, in contact with a bed of limestone, of which, indeed, it forms almost a portion, the two materials appearing to have been precipitated in immediate succession from the same waters.

Argillaceous Iron Ore is another constituent of the coal strata to which a chemical origin is attributable. It occurs as the *carbonate* of iron, usually in courses or bands of nodules enclosed in the softer shales, and especially in the fire-clay which underlies almost every seam of coal. The ore likewise exists in continuous though thin layers, particularly when in contact with one of the deposits of limestone.

Interstratified among these various deposits are the seams or beds of the *coal* itself, a product of neither mechanical nor ordinary chemical action, but of *Vital* agency, namely of vegetation. These seams are of all degrees of thickness, from a few inches to many feet. This valuable material, coal, is found within the limits of the State in nearly all its known varieties—in some districts under the form exclusively of compact anthracite, in others under that of a very fusible bituminous coal, and in others, again, exhibiting every intermediate proportion of bitumen which it is possible for coal to contain. The place of the principal coal-seams among the extensive group of strata composed of the foregoing varieties, is towards the middle of the formation, neither the very lowest nor the highest portions containing any extensive seams of sufficient thickness to be valuable.

Area and General Distribution of the Coal Strata.—The Coal-measures within the limits of Pennsylvania cover an area of about 12,623 square miles, or not much less than *one-fourth* of the whole surface of the State. They occupy two distinct regions, one of which contains only anthracite, or non-bituminous coal, and the other only the Levant bituminous varieties. The superficial extent of the bituminous coal-measures greatly surpasses that of the anthracitic strata. With

one partial exception, the two sorts of coal do not coexist in the same basin, nor indeed in the same region.

The positions of the several anthracite basins have been already defined ; the more precise limits of each will be traced in future chapters.

We now proceed to sketch the general boundary of the vast area occupied by the bituminous coal strata.

Limits of the Bituminous Coal-Measures.—Almost the whole of the bituminous coal of Pennsylvania lies to the N.W. of a line following the main crest or escarpment of the Alleghany Mountain from the Maryland State line to the Susquehanna, thence up the river to the Sinnemahoning, and up this latter stream to the sources of Trout Run, extending thence North-westward to Warren, and from Warren W.S.W. by the course of the Alleghany River to Franklin, and from Franklin to the Ohio State line at Sharon, in Mercer County. On the W. the limit is the State line of Ohio, and on the S. it is that of Virginia.

Besides this great and almost unbroken coal-field, there are several insulated tracts outside of the boundary here drawn. One of these is the Wills' Creek basin, in the S.E. corner of Somerset County, the part in Pennsylvania being but the extremity of the Potomac Basin of Maryland ; another is the coal-field of the Broad-Top Mountain in Bedford ; a third, that of Towanda Creek in Bedford ; a fourth, that of Blossburg in Tioga. All of these are destined, from their positions to markets, to be hereafter of much value in the coal or iron commerce of the State.

There are several other smaller detached patches of the coal-formation in Luzerne, Lycoming, Tioga, Potter, and M^c^Kean counties, but these are of less relative importance. I reserve for a subsequent Chapter a more exact delineation of the limits of the coal strata both of the great Trans-Alleghany coal region, and the smaller outlying tracts to the E. and N.

Within the general boundaries sketched above, the coal strata almost everywhere underlie the soil. The only tracts where other formations emerge and subdivide the coal region, are the summits and slopes of the long narrow anticlinal ridges, the Negro Mountain, Laurel Hill, and Chestnut Ridge, except, indeed, on the Northern and North-western edge of the district, where, as in the neighbourhood of the Sinnemahoning, the same lower strata intrude a little within the general boundary. The coal-formation, therefore, occupies nearly the whole of Somerset and Cambria, the greater part of Clearfield, a corner of Clinton, one-half of Elk, the chief part of Jefferson, a corner of M^c^Kean, and the adjacent corner of Warren, a part of Forest, nearly all of Venango, and of Mercer and Lawrence, besides the entire surface of Clarion, Indiana, Armstrong, Butler, Beaver, Alleghany, Washington, and Green, together with nearly the whole of Westmoreland and Fayette counties.

Ample as this wide area of our inexhaustible deposits of fossil fuel appears, it constitutes but a small portion—only the N.E. extremity, indeed—of a coal-field of much more stupendous size, the great Appalachian basin, extending continuously to Alabama, the largest and richest coal region on the globe.

This enormous coal-field, beginning at the N.E. in Pennsylvania, as already shown, ranges South-westward through Ohio, Virginia, Maryland, Kentucky, and Tennessee, and only terminates in the interior of Alabama. Its total length is about 875 miles, and its greatest width, measured from the escarpment of the Alleghany Mountain to Akron in Ohio, is about 180 miles. I

estimate it to cover very nearly 70,000 square miles, and to constitute more than *one-third* of the total known area of coal strata in the world. As the central or deepest portion of this prodigious basin coincides nearly with the "Long Reach" of the Ohio River, between Marietta and the mouth of Fishing Creek, it is obvious that the South-western counties of Pennsylvania are situated far enough within the trough to embrace the coal-formation in nearly its greatest thickness, and I have ascertained that only one or two valuable coal-beds, the very highest in the basin, fail to enter the State. The chief of these is the Carr's Run, or Pomeroy Seam, so extensively and profitably mined on the Ohio River.

CLASSIFICATION OF THE COAL ROCKS, AND THEIR MODIFICATIONS OF TYPE.

CLASSIFICATION.

The Coal-formation of Pennsylvania, especially under its Western development in the great Appalachian Basin, demands a fivefold subdivision. The strata naturally group themselves in the following sets or sub-formations :—

1. Seral Conglomerate.
2. Older Coal-measures.
3. Older Coal-shales.
4. Newer Coal-measures.
5. Newer Coal-shales.

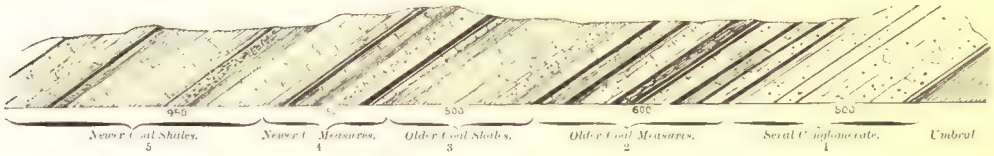


FIG. 137.—Subdivisions of the Coal Series of Pennsylvania.

I.—THE SERAL CONGLOMERATE.

General Characters.—This well-characterised and widely-distributed member of the Coal series consists, in its ordinary or typical condition, of grey and whitish quartzose conglomerate in massive beds, alternating with grey and yellowish sandstone. In many districts it includes one or more thin seams of coal. In the anthracite region it is a very heterogeneous deposit, consisting of thick and ponderous sheets of an extremely coarse, firmly-cemented, and massive rock of quartzose, and other pebbles, of all sizes, from the smallest to that of a hen's egg ; of coarse grey sandstones, sandy shales, rough coal-slates, and even in some quarters thick and valuable beds of coal ; but this diversity of composition grows less as it passes Westward beneath the bituminous basins. There the pebbles are smaller, and the rock has rather the aspect of a coarse silicious white pebbly sandstone than that of a conglomerate, and its parts cohere much less closely. A full synoptic account of this member of the Coal series, in all its modifications of composition and thickness, has already been given in the Introductory Book, Chapter III., page 146. From that exhibition of its various types, we can see at a glance its remarkable gradations as it spreads toward the N. and W. It is an extremely persistent deposit, and accompanies the Coal-measures of the great Appalachian basin everywhere, not merely in Pennsylvania, but throughout the other States to the S.W., forming invariably their floor. As it thus underlies both the anthracite and the bituminous Coal-measures, and in fact alternates intimately with their lowest

coal-beds, it establishes conclusively the identity in age and origin of these two externally dissimilar sets of Coal-measures. That it is properly itself a subdivision of the Coal-measures is shown in its containing regular and even thick beds of the coal, identical in composition with the seams of the generally productive overlying group, and also in its enclosing innumerable genuine fossil coal-plants, especially the fragmentary stems of Lepidodendra, Sigillaria, and Ferns.

II.—LOWER COAL-MEASURES.

Anthracite Region.—It has just been intimated that the older or lower division of the Coal-bearing strata rests directly on the Conglomerate, and that the two are indeed closely united by an alternation of their contiguous beds. It is, therefore, impossible to assign a well-defined permanent horizon of separation; but considerations of convenience dictate that we place an arbitrary boundary at the bottom of the first or lowest considerable coal-seam. The upper limit of the older coal group is entirely arbitrary in the anthracite basins, but considerations of convenience dictate that we place it in the rocks which immediately underlie the great Mammoth seam of the Pottsville district. The anthracite Coal-measures embrace the following classes of strata :—

1. Coarse grey micaceous sandstones, and near their lower limits a few massive beds of conglomerate.
2. Grey and bluish argillaceous sandstone.
3. Compact blue slate, frequently covering the coal-beds, and also occurring in independent strata.
4. Blue compact shale of rather fine texture, having frequently an irregular and splintery fracture, and containing rootlets of Stigmaria. This is the prevailing floor of the seams of coal; it is a somewhat coarse or silicious fire-clay.
5. Beds or seams of anthracite coal.

The slates and shales of the anthracite measures are, on the average, more silicious and sandy than the argillaceous deposits of the bituminous basins. Some of these shales are very slightly calcareous; but in all the anthracite basins there is not *one bed, however thin, of true limestone.*

Particular layers of the blue argillaceous shale contain nodules of *clay iron-ore,* or argillaceous carbonate of iron, in more or less well-defined courses. This species of ore, so general an accompaniment of coal shales in all parts of the world, chiefly abounds in the *lower* portion of the lower anthracite measures; it is plentifully met with, and purest, in the under shales or fire-clays of the coal-beds. Throughout all the anthracite basins the ore, as a general rule, is more silicious in its composition than that of the bituminous measures W. of the Alleghany Mountain, and the surrounding shale adheres more firmly to the nodules, causing an increase of labour and expense to cleanse them for the furnace.

Thickness.—To estimate the total thickness of the older anthracite measures is not easy, owing to the impediments to exact measurement from contortions of the strata and extensive dislocations intersecting the formation.

Along the Southern side of the Pottsville Basin the strata of this group, ranging in the

Northern slope of the Sharp Mountain, have their thickness obscured by an excessive squeezing of the coals and softer measures. We must have an estimate, therefore, on measurements of the formation on the Northern side of this basin, or on data collected in the other coal-fields. The total thickness of the Coal-measures of the Pottsville Basin on Silver Creek is about 3000 feet, measuring from the upper beds of unproductive conglomerate to the synclinal axis at the Schuylkill. Of this mass, about 967 feet lie below the Skidmore seam, or belong to the lower White-Ash group; 330 feet represent the upper White and Grey Ash group, ending with the Black Valley coal; and about 1261 feet, the Red-Ash series to the Peach Mountain bed inclusive. In other districts the relations of these several groups in respect to thickness, and the number and dimensions of their included coals, will be very different, so that no general statement can be given which will fairly express their average development in the anthracite country; but the above will serve as one instance. The various sections and details to be hereafter presented will offer many more.

Many of the coal-beds of the inferior group have a thickness which is truly extraordinary, and this is not local, but belongs to them throughout their entire line of outcrop in all the anthracite basins. Each of these basins contains two or more great beds of coal which surpass in size any others known in North America, and rival the thickest in the world. The larger beds are in some districts from 25 to 30 feet thick, and by the occasional thinning-out of the intervening rocks, two or more thick seams sometimes coalesce and form one of still greater dimensions.

The Older Bituminous Coal-measures.—The strata present features which deviate somewhat from those of the lower anthracite group. The conglomerates of the lowest anthracitic seams are in the Western or bituminous basin represented by coarse silicious grey and yellowish sandstones, containing occasionally a more or less abundant sprinkling of small and well-rounded quartzose pebbles, imparting to them a partially conglomeritic character. These sandstones derive their yellowish stain from the hydrated peroxide of iron. Similar sandstones fill up a portion of the wider intervals between the coal-beds throughout this older group. These arenaceous strata, more especially the inferior ones, are the main reservoirs of the *brine*, which is tapped by the artesian borings at so many localities in the bituminous region. Either the older anthracitic conglomerates and sandstones were never impregnated with salt as these were, or their more crushed and uplifted condition has caused it to filter away to inaccessible depths; or what is more probable still, the steaming which the anthracite Coal-measures underwent during their metamorphism has exhaled the chloride of sodium which they contained.

As a general rule, the sandstones of the older bituminous measures are much softer, finer-grained, and more argillaceous than the arenaceous rocks of the anthracite. The shales and slates are less sandy, and have a finer texture, and the fire-clays are more purely argillaceous; but the most striking distinction is the absence of limestone and calcareous matter in the anthracitic regions, and their frequent presence in the bituminous. These constituents of the strata progressively augment in the older Coal-measures as we advance Westward from the Alleghany Mountain; the shales become steadily more calcareous and marly, and the beds of limestone thicker and more numerous. In the main Western basin there are usually three deposits of limestone, distinguishable not only by their aspect, but, wherever they are fossiliferous, by their organic remains. It is in this lower group of coals that one of the principal

beds of chert occurs. Here likewise are nearly all the layers of iron ore which belong to the bituminous Coal-measures.

The *thickness* of the older bituminous measures in the district of the Alleghany River is apparently about 600 feet.

III.—OLDER COAL-SHALES, OR LOWER BARREN GROUP.

Between the lower and upper Coal-measures there is interposed a group of strata which in the bituminous region contains no coal-seams of notable dimensions.

In the anthracite basins this barren group of Western Pennsylvania is not recognisable. Indeed, it has not been possible, after very patient study, to co-ordinate the individual coal-beds, or the different groups of the coal-measures of the bituminous coal-field, with those of the anthracitic. In the Western coal-fields this group includes not only several thick strata of soft argillaceous sandstone, but various deposits of red, yellow, and blue calcareous shale or marl, and two or three unimportant beds of argillaceous limestone. The coloured aspect of these shales, some of which are brightly tinted, enables the observer at once to recognise them, and to ascertain his place in the formation. This feature grows more and more conspicuous as we advance from the Alleghany Mountain westward into Ohio. The limestones likewise augment in thickness in the same direction, being in the basins near the Alleghany Mountain only a few feet thick, but amounting at Pittsburg to about 30 feet. Their position is near the top of the group. This lower barren group has for its inferior limit the top of the Upper Freeport coal, and for its superior boundary the bottom of the great Pittsburg bed. About 300 feet of its upper strata are visible near Pittsburg, between the level of the Monongahela River and that of the main coal-seam of the district.

Very little iron ore occurs in this division of the coal series. Some of the layers of limestone contain interesting and distinctive species of fossil shells, corals, and other remains indicative of a marine origin for some parts at least of the formation.

IV.—UPPER OR NEWER COAL-MEASURES.

Above the older Coal Shales of the Bituminous Coal-measures of the main Western basin there occur several seams of coal, the two lowest of which, the Pittsburg and the Waynesburg beds, and occasionally a third, are valuable beds.

The first of these is a deposit of very great value.

For the sake of convenience I have grouped together these uppermost workable beds under the name of the Upper or Newer Coal-measures. That part of the formation which embraces them, measuring it from the bottom of the Pittsburg coal to the top of the Waynesburg seam, has an average thickness of from 200 to 240 feet. It consists in the more Eastern bituminous basins of argillaceous sandstones, calcareous shales, and thin layers of limestone ; but as we pursue it Westward across the Monongahela to Wheeling the sandstones progressively fade away, the shales become more calcareous, and the limestones greatly increase, until these two latter kinds of rock constitute on the Ohio River the principal materials. In this portion of the series we meet with almost no clay iron-ore.

It is not easy to determine what portions of the coal series of the anthracite basins represents the upper productive coal group of the bituminous region, nor is it at all certain that any part of the classification natural for the Western Coal-measures will apply to the Eastern. The mutability of all the coal strata on a large scale, shown by the thinning-out and coming-in of the coal-beds and the rocks which separate them in both coal regions, should discourage any expectation of our ever successfully co-ordinating the individual deposits of the two districts, though we are well convinced they were once united and continuous. I shall therefore refrain from a closer parallel between the two sets of strata.

V.—UPPER OR NEWER COAL-SHALES, OR UPPER BARREN GROUP.

It is questionable whether any part of this the uppermost division of the coal-rocks has been preserved from denudation in the anthracite basins, if, indeed, it ever existed there.

The group is distinctly recognised only in the South-western corner of the State, W. of the Monongahela River, and S. of the Ohio. There, in the hills of Green County, the total thickness of the group amounts to between 900 to 1000 feet. It includes four or five thin seams of coal which seldom expand to the thickness of 2 feet, and are therefore of little or no value. It contains also a number of thin beds of limestone, from 2 to 5 feet in thickness, but the chief strata are sandy shales and flaggy micaceous sandstones more or less argillaceous. Some of the shales are calcareous, and when this is so, the overlying soil has more fertility than usually belongs to the group. No iron ore, in any notable quantity, has hitherto been discovered in this part of the formation.

Having in the foregoing sketch given a brief general account of the composition of the coal strata of Pennsylvania, I shall proceed to a detailed description of the several anthracite basins of the Eastern Carboniferous District.

ANTHRACITIC COAL STRATA.

I.—BOUNDARIES OF THE SEVERAL COAL BASINS.

The general limits of the region, embracing the anthracitic Coal-measures, have been already sketched, and it was stated that the area actually covered by the coal-bearing strata is small in proportion to the whole territory within which they are distributed.

An inspection of the geological maps will show that the three long and nearly parallel areas of the coal strata, separated from each other by anticlinal belts of the Middle Palæozoic rocks, are all, if we except the more simple Wyoming Basin, rather groups of synclinal troughs than solitary basins.

The Southern Anthracite Basin, or the Schuylkill or Pottsville Basin, extends from the Lehigh at Mauch Chunk westward between the Locust and Broad mountains on the N., and the Sharp Mountain on the S., in a gently widening valley to the waters of the Swatara, near Tremont, where it separates into two contracting prongs, the N. and shortest of which stretches Westward to its termination as the Wiconisco Basin between the Bear and Wiconisco mountains ; and the Southern, known as the Dauphin Basin, bounded by the Sharp and Fourth mountains, reaches to within 3 miles of the Susquehanna River. Intimately connected with this great basin is the

smaller and closely-adjacent coal-valley N. of Mine Hill. This slender trough is called the *Mine Hill Basin.* North of the Mine Hill Basin there are other smaller ones in the Broad Mountain.

The Eastern Middle or Lehigh Basins include the Spring Mountain, the Beaver Meadow, the Pismire Hill, the Hazleton, the Big and Little Black Creek, and the Bucks Mountain basins, besides the small coal-fields of Green and McAuley's mountains. This group of *seven* elevated and relatively shallow coal-valleys is bounded on the N. by the Bucks and Green mountains, E. by the valley of the Lehigh, S. by the Spring Mountain, and W. by the valley of the Catawissa.

The Western Middle Group of Basins comprehends those of Mahanoy and Shamokin ; but towards the E. each of these divides into three distinct branches, and thus there are in that quarter six lesser shallow troughs. The whole group is bounded on the N.E. and N. by the valley of the Catawissa and its branches, and more immediately by the ridge of the Big or Shamokin Mountain and the Head Mountain ; S.E. and S. by the valleys of Locust Creek, and the Big and Little Mahanoy creeks, but more immediately by the Broad Mountain and the Mahanoy Mountain. The basins of Broad Mountain are on the high broad anticlinal table-land of that name, between the Mine Hill and the Mahanoy basins.

The Northern or Wyoming Basin is bounded on the N.W. by the general rim of mountain locally known as the Lackawannock, Shawnee, Plymouth, and Nanticoke ridges, and on the S.E. and S. by the Moosic and Wyoming mountains. From the N.E. end of the basin near Carbondale, where the Lackawannock and Moosic ridges unite, it gradually expands, until at Pittston and Wilkesbarre it is nearly 4 miles wide. W. from this central district it again contracts, the N. and S. crests which confine it closing together at Beach Grove, where the Susquehanna cuts across them near their junction. In its general form this, which is the most regular and picturesque of the anthracite basins, is a long crescent-shaped valley, one horn of the crescent pointing N. and the other W.

II.—COMPOSITION OF THE SERAL CONGLOMERATE IN THE SPECIAL TYPE WHICH IT PRESENTS IN THE ANTHRACITE REGION.

In the Anthracite districts, the immediate floor and geographical boundary of the true Coal-measures, is the easily recognised Seral conglomerate. From the fact of its great hardness, compared with that of the argillaceous Coal-measures on its one border, and that of the Umbral red shale on its other, the denuding waters which wore down those soft formations into valleys have left it, especially where its dip is steep, projecting high above them in bold and well-defined mountain-crests or ridges. All the coal basins just defined are therefore encircled by conspicuous natural barriers of this thick and enduring formation.

In its mineral constitution, the Seral conglomerate of the Anthracite is, as already stated, a coarse, rather heterogeneous, but mainly quartzose mass, made up of grey conglomerates, white, grey, and brownish sandstones, and a few thin beds of dark carbonaceous slate, the conglomerates forming the largest and most characteristic portion of the mass. This somewhat diversified structure belongs especially to its more S.E. outcrops ; for traced N.W., especially into the bituminous region, it assumes more and more the simple aspect of a grey silicious conglomerate and whitish sandstone. Its heterogeneous composition is well shown in the first or

Southern basin, especially as it is developed in the Sharp Mountain, where it is not only thickest, but has its greatest complexity of type.

In this outcrop, under an *average* thickness of about 1200 feet, it presents three subdivisions. The *Lower division* embraces—

1. Yellow and grey sandstones, alternating with thin beds of *red shale*, identical with the Vespertine red shale, and containing a few scattered quartz pebbles, some of which are large. This division, which exhibits a passage from the Umbral to the Seral deposits, is from 60 to 70 feet thick.

2. Massive beds of a conglomerate composed of quartz pebbles in a paste of disintegrated green slate. These beds also include layers of red shale. The thickness of this portion is from 10 to 20 feet. In the very lowest bands of this rock, especially those which alternate with, or are imbedded in, the upper layers of the Umbral red shale, this imbedding material is greenish, and sometimes quite yellow. This green tint is due apparently to a mixture of triturated *chlorite slate* or metamorphic clay-slate, chloritic and talcose in aspect, mingled with the sand. These greenish conglomerates of the base of the formation are very beautiful, and were they only of a material which would admit of being dressed or polished, they would be valuable for ornamental uses.

These rocks are well exposed on the back track of the Lehigh Company's chain of roads, especially between the Old Mauch Chunk Tunnel and the crossing of the tracks. In this neighbourhood we have fine exhibitions of some of the coarser beds, and may see masses containing quartzose and sandstone pebbles not less than 5 or even 6 inches in diameter.

Other layers of this lower conglomerate group are more uniformly composed of white quartzose pebbles, but even such beds have their pebbles less closely set and less regular in size than we find them in the layers of the main upper division.

This lower group forms the S. crest and upper steep S. slope of the Sharp Mountain.

3. A coarse silicious conglomerate of large and irregular pebbles, chiefly of milky quartz, but with others resembling the *Primal* and *Matinal* slates; and a few of dark-grey sandstone, of perhaps the same age. Among these pebbles none are found referable to the granitic or gneissic rocks. In some localities the quartz pebbles of these lower strata are of extraordinary dimensions; thus, in the Head Mountain they often exceed 8 inches in their longest diameters. Many of the pebbles in this division of the formation appear to have been derived from the Levant sandstones of the type seen in the Kittatinny Mountain; others seem to have come from the Primal white sandstone.

4. Chiefly yellow and white sandstones, with included layers of a grey grit, composed of pebbles of crushed slate.

The *Middle division* of the formation consists chiefly of thick irregular obliquely-deposited beds of a hard blue rock made up of quartz, sand, clay, and small pebbles of slate. In the Sharp Mountain this part of the formation embraces beds of slate, almost identical with the slates which enclose the coal-seams.

There is also much *oblique deposition* or *false bedding* visible in these sandstones, confirming the evidence afforded by the coarseness of the conglomerates, of the energy of the currents which swept the materials together. From the prevailing direction of the dip of these oblique

plains of deposition, we are entitled to infer that the strewing currents moved towards a point a little West of North.

This obliquity of bedding in the conglomerate is conspicuous in all its other outcrops, and it is well worthy of note that in them it usually indicates the same North-westerly movement of the waters implied by the Sharp Mountain beds.

At least one bed of coal, sometimes of a thickness fit for mining, usually occurs in this division. Near the E. end of the basin the thickness of this middle group is probably not less than 200 feet. It is the cause of the flatness of the summits of both the Sharp and Locust mountains throughout the range from Mauch Chunk to the Little Schuylkill.

The *Upper division* of the formation, both in the Sharp Mountain and around the Anthracite basins, generally has a more uniform composition than the beds beneath. Many of the more massive strata are composed solely of large pebbles of white quartz of nearly similar size and shape, packed together with great regularity. These are somewhat ovoid, smooth, or actually polished, and in close contact, their larger dimensions parallel with the plane of bedding. This feature is conspicuous in many of the upper strata of the Sharp Mountain from Pinegrove westward, but from Pottsville eastward a less degree of uniformity prevails. The upper conglomerate is excessively hard to drill, yet it was long ago successfully tunnelled in the Sharp Mountain, by the Lehigh Company, near Mauch Chunk. It generally constitutes the crests of the Sharp and Locust mountains, and often stands forth in a naked rugged wall immediately behind the outcrop of the great coal-bed of the basin.

Where the conglomerate forms the barrier of the Beaver Meadow Basin, both the *Upper* and *Lower* portions contain a somewhat large proportion of argillaceous matter, traceable apparently to the abrasion of the numerous slate pebbles. This argillaceous material, mingled with silicious sand, is the cement in which the larger pebbles are imbedded in some of the less compact conglomerates, which derive, from this slaty matter, their characteristic agreeable green colour.

Of the reduction in the *coarseness* of the conglomerate, as we compare it in its successive outcrops more and more towards the N.W., there is the amplest evidence. Passing from the Sharp Mountain to the Broad Mountain on the N. side of the same basin, there is a perceptible diminution in the pebbles, and an approximation to greater uniformity of size. Another step brings us to the Head Mountain, where one of the lowest beds has a degree of coarseness and irregularity of composition met with in none of the other outcrops; for though the pebbles in the same part of the formation W. of Pinegrove are of great size, they are more regularly oval, and imply a more prolonged attrition. Those of the Head Mountain suggest by their great size and irregular forms, compared with those of other localities, that these were driven by waters endowed with a more than ordinary velocity, moving great columns or streams, pushing violently through the general broad flood while it was dispersing the vast sheet of sand and pebbles.

Advancing to the outcrop of the Spring Mountain, the conglomerate is seen at the notch or gap of Hazle Creek with its pebbles considerably smaller, the beds of slate somewhat thinner and less numerous, and the sandstones and conglomerates less abruptly separated. The pebbles are more even in size, and are packed together with less of interposed sand.

Around the Wyoming Basin, the conglomerate exhibits this modification in a still higher

degree, the pebbles there being more uniformly quartzose, and from half an inch to one inch in diameter, and set closer together with but little interposing cement.

While these features of coarseness and irregularity of composition decline towards the N.W., the oblique bedding, the other symptom of turbulence in the waters, likewise progressively abates. All of these instructive changes occur in a distance across the outcrops of hardly 30 miles—much complexity of internal structure being succeeded at this interval by features of uniformity, which approximate to those still more typical characters which the formation retains with such amazing persistency throughout its vast spread beneath the bituminous coal-fields.

Of the gradation in thickness of the Anthracite conglomerate, our measurements already given (see pp. 146, &c., vol. i.) show that the mass has its maximum development in the Sharp Mountain, and diminishes steadily towards the N. and W., but fastest in the W.N.W. direction. In all of the Anthracite basins there is a declension of the thickness from a certain meridian, at least towards the W.S.W.; but this is only a feature of the yet faster thinning towards the quarter above stated.

That this N.W. declension in the thickness and coarseness of the Seral conglomerate, so obvious in the Anthracite region, extends to the bituminous districts, and is in fact a *general law* of the formation, is amply demonstrated in the tabulation already referred to, where its thickness and composition are indicated as far as Tioga County.

In the bituminous coal-field of *Broad-Top Mountain* in Huntingdon and Bedford, the rock exists chiefly as a light-grey coarse silicious sandstone, with but little of the conglomeritic character. At Wray's Hill, on the edge of this high plateau, it measures not more than 250 feet. And this estimate accords well with observations made at other places in the basin. In this district, as in the Anthracite basins, the rock embraces one or more beds of coal, showing that it is as elsewhere a part of the coal-formation.

This basin of Broad-Top Mountain lies not more than 30 miles to the E. of the Alleghany Mountain, the margin of the great bituminous region. In relative position it is therefore a very little more to the N.W. than the Wyoming Valley, and may be viewed as an intermediate station between the Anthracitic and Bituminous coal districts.

Passing to the bituminous basin N.W. of the front ridge or main escarpment of the Alleghany Mountain, the formation, as there developed in the first basin N.W. of the Anthracite region in the *Loyalsock* district, is a white silicious conglomerate, measuring from 60 to 80 feet. On the *Tangascootack*, which is nearly in the same belt, but further towards the S.W., it is a white friable sandstone, sprinkled with small quartz pebbles, and it measures about 100 feet. Along this first belt of basins N.W. of the Alleghany Mountain, the conglomerate generally varies in its thickness from 60 to 150 feet, and exhibits as great a proportionate fluctuation in the coarseness of its ingredients. In some localities it is little else than a white silicious sandstone, while in intermediate places it contains much true conglomerate, in some of the beds of which the pebbles are occasionally an inch or more in diameter.

This local coarseness of the fragments is traceable as far to the N.W. as Bennett's Branch of the Sinnemahoning, and is a further proof, that while the currents which dispersed this submarine drift moved in the manner of a broad sheet of waters, they contained columns of great momentum, as the distance this gravel was transported could not have been *less* than 200 miles, and may have been much more.

Advancing W. from the Alleghany Mountain, the Seral conglomerate undergoes but a trivial further reduction in its thickness, even when traced the whole way across to Mercer and Warren counties.

On Drake's Run, a tributary of the Youghiogheny, it is nearly 100 feet thick, and along the N. and N.W. final outcrop of the formation its average thickness is from 60 to 75 feet, though in some districts it measures not more than 20 feet. It should be observed that not only does the stratum itself thus locally fluctuate, but the measurements are liable to error by embracing sometimes the next overlying sandstones, where the intermediate coal-seam and its slates are either locally absent or concealed by the soil. Indeed, this local interpolation and disappearing of the lower coal-beds, and the consequent dividing and uniting, thickening and thinning-out, of certain strata, would, even if the whole formation were laid open to the day, render it impossible to trace either the whole conglomerate or any member of it, however well defined its boundaries might be at starting, the entire distance, or perhaps one-third of it, across this enormous coal region. We might set out with a perfectly sharp plane of separation between the conglomerate and the underlying red shales, and call this the common boundary of the Seral and Umbral formations, and might follow this limit without ambiguity for many miles ; but upon pursuing it still further, we should inevitably discover that our horizon was becoming uncertain by the wedging-in from the W. of another bed of similar composition, beginning with a mere feather edge, but thickening steadily, while the portion of the red shale insulated between it and the main conglomerate underwent a corresponding thinning in the same direction, until at last the original plane of separation would vanish by the junction of the two conglomerates, and the now visible boundary would be the bottom of the newly-interpolated bed. The cause of this shifting of the horizons of separation between strata, so conspicuous in the carboniferous rocks of Pennsylvania, will be discussed in a future chapter, where the mode of formation of our strata, and the theory of deposition generally, will be specially discussed.

DIVISION I.

DETAILED DESCRIPTION OF THE SOUTHERN OR SCHUYLKILL BASIN.

CHAPTER I.

GENERAL STRUCTURE AND TOPOGRAPHY.

It will be seen, by consulting those portions of the Geological Maps which embrace the anthracite region, that the Southern coal-basin, ranging from the Lehigh almost to the Susquehanna, is far from possessing a simple configuration or structure. It is, in fact, quite irregular, and consists of five separate Districts.

1. *The Lehigh and Little Schuylkill District.*—From its E. extremity near Mauch Chunk, the mountain-ridges enclosing the basin, diverging from their synclinal knob on the Lehigh, called Mount Pisgah, range W., gradually separating, but with no considerable deviation from straightness, and no break of continuity but the simple notches which give passage to the streams as far as the neighbourhood of Tuscarora and Middleport. The structure of this beautiful division of the valley is that of a rather symmetrical synclinal trough, gradually expanding and deepening towards the W., and confined on each side by steep and regular mountain-slopes. The general synclinal form of the coal-field is preserved throughout this tract, though locally interrupted by several subordinate anticlinal flexures. This part of the basin is about 19 miles in length, and widens W. from a mere point to a breadth of $1\frac{1}{2}$ miles opposite Tuscarora. The average dip of the strata in the Sharp Mountain, its S. boundary, is about 80° N. 22° W. That in the Locust Ridge on the other side is between 50° and 60° S. 20° E. The configuration of the W. portion of this part of the basin is well shown in the background of the sketch representing the Lehigh Summit coal-mine.

2. *The Schuylkill and Swatara District.*—The second division of the basin extends from the abrupt expansion of the valley at Middleport to Lorberry Creek N.W. of Pinegrove. This portion is about 22 miles long, and in its central and widest part about 4 miles broad. The Sharp Mountain is its S. boundary, and Mine Hill its N. In the Sharp Mountain the rocks have been uplifted beyond the perpendicular, so that they lean in an inverted position upon the Coal-measures, dipping at a high angle to the S. instead of towards the N. In some places the dip is perpendicular. This condition of things extends from opposite Middleport to near the W. end of the Dauphin branch of the basin. The structure of Mine Hill, on the other hand, is anticlinal. The monoclinal North-bounding ridge, known as the Locust Mountain, ranges W. into the Broad Mountain, while almost in the middle of the synclinal basin, near Tuscarora, rises the Mine Hill southward of the other, and overlapping it by more than half a mile. The anticlinal

crest of Mine Hill ranges on in an almost straight course in a well-defined summit, exposing the Seral conglomerate, and separating the Pottsville coal-field from a smaller basin on the N., which is called the Mine Hill Basin.

The anticlinal structure of Mine Hill, visible at the gaps of Mill Creek, West Branch, and West-West Branch, gradually declines by the flattening of the arch, which still runs on, however, through the W. plateau of Broad Mountain. Nearly opposite the E. end of the Mine Hill, the Sharp Mountain exhibits a remarkable change in the position of its crest, which suddenly shifts to the S. more than half a mile. The offset is marked by the presence of two anticlinal axes, which, originating outside of the coal-field between the Little Schuylkill and the Lehigh, pass W. through the Sharp Mountain, and throw forward two long declining spurs into the coal-basin, one of which subsides E. of Middleport, while the other, known as Silver Hill, lying nearer the Sharp Mountain, ends S. of that village. Between these two anticlinal spurs lies a narrow and shallow trough or cove of the lower coal-rocks, and between the more S. and the flank of Sharp Mountain another longer and deeper one. It is this abrupt shift to the S. of the crest of the Sharp Mountain, and the rising of the Mine Hill on the other side, which nearly insulates the E. division of the basin from the main central portion. The wider middle part of the coal-field contains a number of subordinate anticlinal flexures, some of them of the form of inverted folds in the Coal-measures, several miles in length, besides many local contortions and irregularities of the dip.

3. *The Mine Hill Basin or District.*—The third division of the S. basin is the separate and smaller synclinal trough N. of Mine Hill. It is between 13 and 14 miles long, and from a fourth or half a mile wide at its E. end, to a mile where it is broadest W. of Hecksherville. Its N. boundary is the Broad Mountain, into which, indeed, its two extremities may be said to penetrate. This Mine Hill Basin forks into two branches at its W. end by the intrusion of the Peaked Mountain.

The fourth and fifth divisions of the main coal-field originate in the vicinity of Lorberry Creek, by the intrusion from the W. of a broad anticlinal belt of the Seral conglomerate and still lower rocks, forming the Little Lick Mountain and the valleys W. of it. This causes the basin to separate into two long and narrow synclinal troughs, the more S. of which is called the Dauphin Basin, and the more N. the Wiconisco Basin.

4. *The Wiconisco Basin.*—This division is nearly 17 miles long, and, measuring from one outcrop of the conglomerate to the opposite one, is from a mile and a half to three-quarters of a mile wide, tapering gradually to a point, with a structure very similar to that of the first or Tamaqua division. Its bounding ridges are the Big Lick Mountain on the S., and the Bear or Thick Mountain on the N., each of them of monoclinal structure, their strata dipping about 45° towards the Coal-measures.

An anticlinal axis appears to range along the centre of this trough, at least from Rausch or Klinger's Gap eastward.

5. *The Dauphin Basin.*—The Dauphin Basin, commencing at Fishing Creek, W. of Lorberry Creek, extends, with a slightly-curved course, obedient to the flexures of the South Mountain, to within 4 miles of the Susquehanna River. It is about 27 miles in length, has a breadth at its E. end of nearly a mile between Lorberry Creek and Fishing Creek; contracts gradually for several miles to half a mile between Rausch Gap and Yellow Spring Gap, and still further Westward,

tapers away to a very narrow belt, the bed of the valley steadily rising all the way until the Coal-measures terminate in a long and acute point, at a level of many hundred feet above the valleys outside of the bounding mountains. The basin is a simple compressed synclinal trough, the strata in the S. side dipping perpendicularly, while those in the N. side decline S. at an average angle of 45°.

UNDULATIONS OF THE STRATA IN THE SOUTHERN COAL-FIELD.

The researches of the Geological Survey, and the experience, often very dearly purchased, of the conductors of our anthracite mines, have at last induced a very general conviction of the necessity of attending to all the anticlinal and synclinal turns of the strata, for it is now admitted that these are the true key to the opening, tracing, and successful working of the coal-seams of the region. If a knowledge of them can be dispensed with, it is only where the operations are on the most local and limited scale. By showing the *lowest* known coal-beds which each given saddle or anticlinal axis lifts to the surface at every cross-ravine and other accessible point along its course, and again the *highest* seams which basin at the surface along each synclinal axis, a faithful description of any undulated district can be made to exhibit not only its structure but its *whole contents* below as well as above the water-levels. In this manner, by good geological maps and sections, we can show what coals are embraced in the saddles and what in the basins; and, moreover, at what heights and depths any particular bed may be reached. If the natural exposures of the strata, and the industrial developments connected with them, were such as to permit a perfect identification and tracing of every coal-seam, and a recognition of every wave or flexure, it would be possible, upon the plan I have adopted for the following detailed description of the coal-field, to represent, with almost the clearness of a model, the form and position underground of every sheet of mineral treasure it contains. But the materials for so thorough a picture do not exist, nor is it probable that they ever will at any one future epoch, since as fresh developments arise older ones are becoming obliterated, or the imperfectly-kept records of them are fading from memory. It is the more important, therefore, that I should define, with all the precision which the existing state of our knowledge allows, and in as systematic a manner as possible, every important undulation. A clear exhibition of these will prove of far greater consequence to the present and future industrial welfare of the district than any account of the existing mines or underground workings, however much of temporary interest this information may possess. The one condition of things is permanent and influential upon all mining operations; the other is transient, every few passing years replacing one state of the workings by others almost wholly different.

Classification and Brief Description of the Anticlinal Flexures or Saddles.—Before proceeding to a detailed description of the numerous anticlinal and synclinal flexures of this coal-field, it will be proper to define the axes of the first class systematically in the order of their distribution. Beginning at the E. end, this order requires us to treat the most Northern first, and to take them in succession Southward and Westward. This slight departure from our ordinary mode of procedure arises from the circumstance that the flexures are disposed in echelon from N.E. to S.W. It will be seen hereafter that the anticlinal and synclinal axes of the Mahanoy and Shamokin coal-field are also disposed in echelon, but in the contrary order, or from S.E. to

N.W.; while in the Northern, or Wyoming Basin, their disposition is from N.E. to S.W., as in the district before us.

In the following synoptic sketch, the successive anticlinal lines or flexures will, where it is possible, be designated by some geographical locality—a village or a colliery; and where greater precision is demanded by some well-known seam of coal arching or basining across them, as the case may be; they are also designated by letters for the sake of still greater precision, and are represented upon the Geological Map of the coal-field by the same. Still better to classify them, the leading anticlinals are designated by capital letters only, the lesser ones by small type.

The synclinal flexures or basins will be named from the anticlinal flexures which confine them; the marginal ones of the coal-field, by their bounding anticlinal and monoclinal belts. It is not intended that this outline-sketch of the primary and secondary flexures of the coal-field shall take the place of the more elaborate descriptions of both the anticlinals and their included troughs to be subsequently introduced, but it is given as a preliminary enumeration, in the belief that it will greatly assist both the practical and theoretical observer in comprehending the subsequent details.

ANTICLINALS FROM MAUCH CHUNK TO PATTERSON AND MINE HILL.

Anticlinal A, *Rhume Run and Panther Creek North Anticlinal.*—This is seen at the Rhume Run arch of coal, and in Panther Creek tunnels, Nos. 7 and 8. It extends from a point in the Sharp Mountain about one mile S.E. of Nesquehoning to a point nearly N. of tunnel No. 2 of the Lehigh Company's mines, or half a mile W. of tunnel No. 8, which cuts it. It curves gently Southward.

Basin A, or Anticlinal A *and Locust Mountain Basin.*—This most Eastern sub-basin of the coal-field, bounded on the N. by the Locust Mountain, and on the S. by anticlinal axis A, originating in the synclinal knob formed by the junction of Locust and Sharp mountains, deepens and widens Westward to the origin of axis A, and then follows the N. side of the valley at the base, and in the S. slope of Locust Mountain to the cessation of axis A. This basin is cut by the Mauch Chunk tunnel, by both of the Nesquehoning tunnels, and by tunnels 6, 7, and 8 of Panther Creek.

It is shown in the Section of the coal-field passing Summit Hill, Plate V. of Coal-sections.

Anticlinal a, *Panther Creek, South Anticlinal.*—This is the small anticlinal of the S. side of Upper Panther Creek, beginning near the head of Panther Creek, and expiring near Coaldale. Tunnel No. 9 intersects it a few hundred feet from the entrance. (See Section of the Coal-field at Summit Hill.)

Basin A a, or Upper Panther Creek Basin.—This is the sub-basin bounded by axis A on the N., and axis a on the S. The middle head-brook, and further W. the main stream of Panther Creek, flow centrally along it. Tunnels 8 and 9 begin in this basin. (See Section of Coal-field at Summit Hill.)

Anticlinal B, *or Summit Hill and Tamaqua Axis.*—This axis extends from Sharp Mountain E. of Mount Jefferson, through Summit Hill, and across the Little Schuylkill to near the mouth of Newkirk Tunnel. Near its intersection by Panther Creek the exposure of this axis is obscure, but there can be little doubt that it is continuous from Sharp Mountain to Newkirk Tunnel. Except near its E. and W. extremities, the flexure is much compressed. It is almost straight.

This flexure is well exposed at Summit Mines (see Section); also at Tamaqua (see Section).

Basin B, or Basin of Locust Mountain and Anticlinal B, *or Ashton and Tamaqua North Basin.*—Its E. end is bounded S. by Sharp Mountain to the beginning of anticlinal B, thence W. by that axis. Northward it is bounded by anticlinal A to Coaldale, thence somewhat further by anticlinal A, thence to Newkirk Tunnel by Locust Mountain. It thus extends, very obliquely, entirely across the coal-field. This synclinal trough is widest, and probably deepest, W. of the cessation of anticlinals A and A, or nearly opposite the middle of axis B. The Coal-measures in this basin are penetrated by tunnels 5, 4, 3, 9, and 2, and further W. by the Greenwood and Newkirk tunnels. (See the Sections.)

Anticlinal C, *Tamaqua Southern and Eastern Mine Hill Anticlinal.*—This axis is probably that which originates in Sharp Mountain at the head of Dry Hollow. It crosses Little Schuylkill through the S. edge of Tamaqua, passes S. of Buckville, S. of Tucker's Slope, and near the mouth of Palmer's Tunnel, and enters the E. knob of Mine Hill west of Big Creek. It then crosses Silver Creek S. of the narrow gorge in Mine Hill, and follows the N. side of the crest of its S. spur to the end, and is probably the arch to the S. of John's Slope on Mill Creek, W. of which it soon expires. The portion E of the Dry Hollow Ridge I propose to call C East, as the connection of this with the main flexure C is not yet fully established by continuous tracing.

Basin B C—Basin of Summit Mines and Dry Hollow Ridge, or of Anticlinals B *and* C *East.*—This is the basin of the Great Summit Mine. It heads E. obliquely on Sharp Mountain, embraces Dry Hollow and the most Southern branch of Panther Creek, and divides W. into *B b* and *C b* by the rising of the anticlinal B. Its N. side is reached by Tunnel 2 in Dry Hollow Ridge.

Anticlinal B, *Tamaqua Middle, and Newkirk Anticlinal Axis.*—This extends from Lower Panther Creek across the Little Schuylkill by the N. edge of Tamaqua to Newkirk Coal Breakers at Reinhardt's Run, beyond which it has not been traced for want of exposures, though it probably runs on for some distance W. For the features of this axis see Section at Tamaqua.

Basin b, or Basin of Greenwood Breaker.—This is the steep synclinal flexure between anticlinals B and B. It is the second, counting S., at the Little Schuylkill.

Basin C b, or Tamaqua and Newkirk Basin.—This is the third, counting S., at the Little Schuylkill. It is a S. branch of basin *B C*, and of basin *C*; Wabash Creek flows in it.

Basin C, or Anticlinal C, *and Locust Mountain Basin.*—This axis is limited on the N. as far W. as Newkirk by axis B, and further W. by Locust and Broad mountains. It is a wide capacious synclinal trough occupying between Newkirk and Tuscarora all the N. half of the coal-field. Westward, it is the Basin of Big Creek between Mine Hill and Broad Mountain. Centrally it contains the Buckville Tunnel, and also the Palmer Tunnel.

Anticlinal C, *Northern Tuscarora Saddle.*—This short axis proceeds from the N. base of Sharp Mountain opposite Buckville through the ridge S. of the Upper Wabash and Schuylkill watershed, and through the centre of Tuscarora village near which it ends. It is a narrow and comparatively unimportant flexure.

Basin C c, or Basin of Watershed, and of Carter's Tuscarora Slope.—This is the most Northern of the three sub-basins of the main Tuscarora Basin, or *C D*.

Anticlinal C C, *Tuscarora Church Saddle.*—This passes through the crest of the S. spur E. of the Valley Railroad, and through the S. Knob of Tuscarora Hill.

Basin c and c c, or Basin of the Centre of Tuscarora Village.—This is a short synclinal flexure of the strata under the village of Tuscarora.

ANTICLINALS FROM PATTERSON AND END OF MINE HILL OR BIG CREEK TO EAST NORWEGIAN CREEK.

Anticlinal D, *or S. Mine Hill Anticlinal.*—This is probably a continuation of the Tuscarora S. axis, undergoing a slight bend Northward between Big and Casca William creeks. It is not traced E. beyond Swift's Creek. This axis is seen in Whitfield Lower Tunnel; at the E. point of S. Mine Hill, and along the N. side of the crest of the same ridge to its Western end; and at Mill Creek, in the arch just S. of John's Breakers, or N. of Mill Creek Colliery.

Basin of C D, or Basin of Tuscarora and of Big Creek Colliery.—At Tuscarora it is probably undulated by the expiring axes C and C C. Further W. it is the basin of the collieries S. of the end of Mine Hill, of Whitfield's Upper Tunnel, and the basin of Casca William Creek between Mine Hill and the Sharp Ridge, called S. Mine Hill, and of John's Colliery on Mill Creek.

Basin D, or Basin of Sharp Mountain and Anticlinal C.—This is the fourth principal basin going W., which, heading in Sharp Mountain, deepens and widens Westward, and descends into the middle of the coal-field. It is the fourth or most Southern synclinal trough at the Little Schuylkill, and is that in which the S. mines at Tamaqua all lie. (See Tamaqua Section.) Opposite Buckville it becomes the basin *C D*, or that of Tuscarora, by the introduction of the anticlinal axis D at the base of the Sharp Mountain.

Anticlinal D, *Axis of Chadwick's Tuscarora Breaker, and of Brockville.*—It lies about 900 feet S. of axis D, and is seen at Chadwick's Mine, on the Schuylkill, S.W. of Tuscarora.

Basin D d.—A short narrow basin, one mile S.W. of Tuscarora, and N.E. of Brockville. It is but part of the small wave D, in the broader basin *D F*, or that of Patterson.

Anticlinal D D.—A short saddle crossing Bushy Valley, 1100 feet (?) S. of anticlinal D (?) or 80 feet (?) S. of Bushy Tunnel.

Basin D F, or Basin of Patterson between the Anticlinal Axes D *and* F.—This basin, commencing at the foot of Sharp Mountain, runs W., with one or two trivial saddles in it (D and D D), to Casca William Creek, where axis E subdivides it. Brockville and Patterson are in this basin.

Anticlinal E, *Casca William, Diamond, and Saint Clair Axis.*—This axis subdivides basin *D E* by rising W. of Bushy; it ranges N. of the S. Diamond Slope of Casca William, through the Big Diamond outcrop of Silver Creek, and through Windy Harbour. It swings the gangways in the Mammoth Vein, W. of Crow Hollow, and shows itself on Mill Creek in a flat undulation in the Primrose coal of Saint Clair.

Basin D E.—This is the basin of the Casca William White Ash Colliery, of the White Ash Collieries on Silver Creek and Zachariah's Run, of the Crow Hollow Mammoth Vein Colliery, and of the Mammoth Vein outcrops at Saint Clair. It is the N. and widest division of the Patterson Basin, and, ending Westward on Mine Hill, is a fifth instance of a synclinal trough running obliquely across the whole coal-field.

Basin E F, or Quigley's Hollow, Crow Hollow, and North Saint Clair Basin.—From Beachem's Mines, S.W. of Tuscarora to Bushy Valley, there is but one basin, that of D and F, the synclinal line of which ranges a little N. of Patterson. But from Casca William to Mill Creek, the axes E and F form a narrow basin, that of the Diamond Slope works on Silver Creek, and

of the head of Crow Hollow, and of the Southern workings of the Mammoth Vein at Saint Clair. It ceases W. of Mill Creek, by the gradual dying-away of the anticlinal axis E.

Anticlinal F, *Patterson and Middle St Clair Axis.*—This axis ranges from Sharp Mountain near Beachem's Tunnel, passes S. of Patterson, arches the Adam Stahl Vein in Bushy Valley, and the lower vein on Casca William Creek; ranges through Quigley's Hollow to Silver Creek, crossing the Switchback road three times, passes Zachariah's Run S. of Windy Harbour, folds the strata at the N. end of the Ravensdale Tunnel, and crosses Mill Creek a little N. of Carey's Shaft, flattening on going W.

Basin F H and G H.—From Schuylkill Valley to Silver Creek the basin N. of axis H is limited by axis F. It crosses Bushy and Casca William creeks with one or two small flexures, the main synclinal axis being S. of the Adam Stahl Vein. From Silver Creek to Mill Creek it is the narrow basin limited on the N. by axis G, where it contains the outcrops of the Upper Diamond Coals. On Mill Creek this basin is that of the Big Diamond and Perpendicular veins. The E. end of this basin spreads S. to Sharp Mountain, on the flank of which it contains possibly one or two undulations.

Anticlinal G, *or Silver Creek Switchback, and Southern Saint Clair Axis.*—This axis, not visible on Casca William, crosses Silver Creek Valley through the S. brow of the hill of the Switchback Road, passes Zachariah's Run between its two close synclinals, Ravensdale near the Perpendicular Vein, and Mill Creek between the Diamond and Hancock veins.

Basin F G.—This basin, which passes through the Switchback Hill of Silver Creek, is that of the N. synclinal fold of Zachariah's Run, that of the Perpendicular Vein on Ravensdale, and that of the folded Hancock Vein in the W. side of Mill Creek.

Anticlinal H, *Sillimanville and Mill Creek Furnace Anticlinal.*—This seems to originate W. of Silliman's, and is the first main saddle N. of the junction of Bushy and Casca William Creeks, and first N. of the Old Furnace on Silver Creek. It crosses Ravensdale and Crow Hollow valleys S. of the Perpendicular Vein, and passes Mill Creek near Patterson's Furnace. It is the axis which bounds the long synclinal of the Peach Mountain coal on the N.

Anticlinal F.—In the N. spur which projects Westward from the N. flank of the Sharp Mountain S. of Patterson and Sillimanville, there are fallacious indications of an anticlinal axis in range with the S. dips of Milford Tunnel; but since its introduction on the Map, evidence has arisen showing that no true saddle exists there.

Basin f, f f.—This is the synclinal belt forming the hill S.E. of Sillimanville, penetrated by the Milford Tunnel. The synclinal axis coincides with the depression between the main crest and the subordinate S. ridge of the hill. This synclinal flexure is probably confined to the base of Sharp Mountain, as its N. dips are not seen W. of the Schuylkill. It belongs properly to the basin S. of axis I, but is not the main synclinal.

The coals embraced in this synclinal are the so-called Clarkson, Charley Pott, and Palmer, and one between the two latter. The Palmer has been mined round the E. end of its basin, from the tunnel back to it again.

Anticlinal F F.—This is an axis occupying the ravine S. of the air-shafts of the Milford Tunnel coals, and N. of the spur immediately E. of Middleport. Its N. dips are those of the basin of Milford Tunnel. No traces of this saddle have been detected at the Schuylkill.

Basin f f, f f f.—The Middleport and New Philadelphia synclinal is evidently this basin pro-

longed into the spur E. of Middleport, and apparently into a recess between the two principal shoulders of Sharp Mountain, corresponding to saddles F F and F F F. The coal called at Middleport the Big Gate Vein, but erroneously so termed, is one of the North-dipping seams of the S. side of the basin.

Anticlinal F F F.—This is the most Southern of the small saddles of the Sharp Mountain group. It comes forth from a spur of the mountain about one mile E. of Middleport, and if prolonged so far, must cross the railroad at the village. E. of the village its position is in the ravine.

This anticlinal appears to be the N. boundary of Steinberger's basin, N. of the main spur of the Sharp Mountain, or Silver Hill, where the successive synclinal outcroppings of several coals have been found by shaftings directed by Dr Steinberger.

Basin of Axes F F F *and* F F F F.—Developed to some extent, as already mentioned, by shafting, this basin has its axis in the nook or recess between the first and second spurs of the mountain, where its coals must successively basin out to the E. This basin crosses through Calahan's and Preston's series of openings, and is probably that embraced between the Southern or middle anticlinals of the latter section.

Anticlinal F F F F, *or Silver Hill Anticlinal.*—This is the axis of the main spur of the Sharp Mountain, Silver Hill, S.E. of Middleport, and, assisted by the other shorter saddles just described, appears to have been the principal cause of the remarkable spreading-out of the Sharp Mountain on its N. flank in this region, as well as of the conspicuous deflection which its crest undergoes.

On this axis, between the W. end of the spur S. of Middleport, and its junction with the main ridge, some seven different coals have been opened, or partially mined. One of them has been penetrated by a tunnel by Mr Dobbin, reaching a coal from the S. side, which presently bends over the saddle, and in the curve of the gangway establishes the exact position of the axis.

As this axis rises rapidly Eastwards to where it lifts the conglomerate floor of the Coal-measures, and as the Sharp Mountain S. of it is not inverted, so as to give room in the basin between this and it for a thick succession of coals, we conclude that those which here arch the anticlinal are rather low in the series.

This axis is probably the most Southern exposed in the coal-openings of Calahan's section, N. of the so-called South-dipping Tunnel and Blackman's coal-seams. It appears to be that likewise which, at Preston's collieries, S.E. of New Philadelphia, arches the so-called Gate Vein.

It is probable that an intermediate saddle may lie between F F F and F F F F. The position of Steinberger's synclinal, so far S. from the saddle F F F, leaves some room for such an axis, and suggests the conjecture.

Upon the view we are inclined to take of the course of this axis Westward, it cannot be the true anticlinal of the Gate Ridge of Pottsville, but is one saddle, and possibly two, N. of that.

There seems to be a saddle in the N. crest of Bare Ridge, between Pinkerton's lower and upper tunnels, and one corresponding in range with it at Hevener's opening in Bare Ridge, E. of Cwmbola, and it is probable that this is the axis of the Main Sharp Mountain spur.

Basin of F F F F *and Sharp Mountain.*—Between the anticlinal F F F F and the monoclinal crest of Sharp Mountain, there is a regular high trough of the Coal-measures which we have thus designated. The Sharp Mountain strata of the S. side of this basin dip very steeply N., but are not overturned; those of the S. flank of the anticlinal spur are more gently inclined. The lower coals extend Eastward in this trough perhaps two-thirds of a mile beyond Dado's Tunnel, basining

out with considerable regularity at a high level, but the extreme limit of the lowest seams has never been established.

This basin seems to be that of the South-dipping coals of Calahan's and Preston's southernmost developments, and is probably the synclinal of the N. side of Bare Ridge or Pinkerton's Upper Tunnel.

Dado's Tunnel in Sharp Mountain, cutting two coal-beds, intersects the steep N. dips of the S. side of this basin.

MAIN GROUP BETWEEN TUSCARORA AND MILL CREEK.

Anticlinal I—*Folded Anticlinal Flexure of Peach Mountain.*—South of the folded trough of the Peach Mountain coal, at a distance from it of from 400 to 600 feet, ranges a leading anticlinal axis, the first traces of which, towards the E., we detect in the hill S.W. of Milford Tunnel. It displays itself on Casca William, S. of the mouth of Bushy, on Lick Run near Murray's Mines, and on Silver Creek, disguised by close inversion in the hill just S. of the Old Valley Furnace. From Silver Creek we trace it to Zachariah's Run, which it crosses S. of the Silver Creek road, which is the position of the synclinal Peach Mountain Vein. We find it again in Ravensdale, in the hill near its mouth, and from Crow Hollow to East Norwegian it pursues the N. crest or shoulder of the double-topped hill S. of the Peach Mountain Basin. In all this distance this is the anticlinal of the Big and Little Tracy coals, and of those next immediately subjacent to them. It seems to have its maximum of elevation and compression in the district of Silver Creek, where it lifts out the fourth or fifth coal underneath the Peach Mountain bed. On Mill Creek and East Norwegian this axis becomes a subordinate roll on the N. flank of the there greater saddle I.

Basin of H and I, or Peach Mountain Basin.—This long continuous trough, commencing at the Schuylkill near Sillimanville, is traceable as far to the W. as the West-West Branch, and probably further. From Sillimanville to Ravensdale it is a simple synclinal, limited on the N. by the anticlinal H, and on the S. by the axis I, but from Ravensdale or Mill Creek westward, the axis I declines in prominence, and the flexure I increasing, this last maintains itself as far as the West Norwegian Valley as a true S. barrier of the trough, still undulated on its S. side by the enfeebled flexure I. Its N. border takes a change between E. and W. Norwegian by the declension of axis I.

The Main Peach Mountain coal follows the synclinal of this trough from Casca William to Crow Hollow, but near Mill Creek that bed has been swept off. But from East Norwegian W. to the West-West Branch or further, this coal retains its position there. In the district of Casca William, the trough is of the extreme normal structure ; that is to say, the N. dip is perpendicular, but from thence W. nearly to Ravensdale it is of inverted or folded type, both sides of the synclinal dipping S. On Mill Creek and East Norwegian the basin is less compressed, even the N. dip being comparatively gentle. On West Norwegian this grows steep again and irregular, and from this valley W. the S. side of the trough is throughout its chief length either perpendicular or overturned.

Anticlinal I.—This anticlinal has not yet been discovered as far E. as Zachariah's Run, but between this valley and Ravensdale, N. of Singley's Farm, we have it plainly indicated, and between Mill Creek and East Norwegian, and from the latter valley W. for a considerable dis-

tance, it is a conspicuous axis—the main S. border, in fact, of the there complex Peach Mountain Basin. Its function is to lift to the day the group of coals next beneath the two Tracy beds.

Basin I i.—From the proximity of the axes I and I, this synclinal belt between them is more frequently a flat undulation on the slope of the one or other of these anticlinals, than a regularly maintained basin or true trough.

Anticlinal J, *or Anticlinal at Cwmbola and Coaquenac.*—This axis has never been traced much E. of the valley of Cwmbola. It may be there recognised as a normal flexure with perpendicular N. dips, under which form it ranges on to Mill Creek, passing S. of Singley's farm. Crossing Mill Creek, it extends to the East and West Norwegian valleys, being inverted in structure everywhere from Mill Creek westward to West Norwegian.

On the East Norwegian it is the closely-folded inverting anticlinal of the coals N. of the outcrop of the Spohn Vein, and by its compressed oblique form and the irregularities of dip connected with it, it is one of the chief causes of the crushed and unsound condition of the coals along its range, as it traverses the Peach Mountain hills between the East and West Norwegian creeks.

Basin J i, or that of the Outcrop of the Lewis and Spohn Vein.—This is a N. division or branch of the main basin, N. of the Great Gate Ridge anticlinal. It occupies the high ground S. of the Peach Mountain coal, and is the obscure basin of the outcrop of the Spohn vein. As a distinct trough it is traceable only from Cwmbola to Middle Norwegian.

Basin J K, or general Basin N. of the Gate Ridge Anticlinal.—The wide belt between the long folded anticlinal flexure, I, of the Peach Mountain coal, and the still more extended and also folded anticlinal of the Gate Ridge, or K, which we shall call the Basin *J K*, is much complicated in its structure, especially towards its E. end, or between Middleport and Zachariah's Run, by the introduction of several lesser anticlinal waves subdividing it into a series of minor basins. The two most Eastern of these are F F and F F F, already indicated. Other three anticlinals occur in a group between the Schuylkill and the foot of Sharp Mountain opposite the mouth of Lick Run. They undulate the coal-seams wrought at Calahan's and Preston's collieries, and the reader will find what is known of their structure and contents in the sections illustrating those localities. Another anticlinal axis interrupts the symmetry of this wide basin S. of Cwmbola. It runs W. from Hevener's Drifts past the mouth of Pinkerton's Upper Tunnel in Bare Ridge, and seems to cease before reaching the Schuylkill.

Synclinal Axis.—The axis or deepest line of this basin is towards its E. end, the synclinal, which passes through Middleport, or *ff, fff* of Sharp Mountain; but W. of New Philadelphia the main depression of the basin appears to be a synclinal axis which ranges through Cwmbola and Belmont, and crosses Mill Creek south of the Sandrock coals, and follows the West Norwegian Valley, where it is parallel with the N. base of the Gate Ridge. This is evidently a very deep basin, containing as its uppermost coals the highest Red-Ash seams of the region.

Anticlinal K—*the Great Pottsville Anticlinal.*—This leading and conspicuous axis appears to originate to the Eastward on the Southern part of Bare Ridge, or probably at the base of Sharp Mountain, as far E., perhaps, as opposite Hubleyville or even New Philadelphia. It passes near Oliver's Bare Ridge Colliery, under the slope of the Selkirk Vein, at Chillis's new slope, and N. of Port Carbon, where it takes the S. side of the crest of the Gate Ridge; but it crosses the Norwegian above Pottsville through the N. brow of that ridge, which it follows thence sometimes along its crest, sometimes by denudation on one or other side, across the West Branch

and the Swatara, and all the transverse valleys to the W. as far as the other side of Fishing Creek, where at last it coalesces with the Fourth Mountain, losing itself high on the Southern slope or even on the summit of this the N. barrier of the Dauphin Branch of the Pottsville Basin. From the passage of the Swatara to Lorberry Creek, this ridge, containing the Pottsville axis, bears the name of the Red Mountain.

This Gate anticlinal is the axis which forms the N. boundary of the S. or subordinate Sharp Mountain Basin. It is especially remarkable for its great length, and for its uniform direction from the point at which it first emerges from the Sharp Mountain, until it ceases to be traceable towards the W. Throughout a great part of this distance its course is marked by a bold continuous ridge, which, rising in height as it extends W., attains its mass and elevation in the neighbourhood of the Swatara, W. of which it again subsides. This ridge constitutes one of the most striking topographical features in the great Southern anthracite coal-field. It contains on its S. side the naturally South-dipping strata appertaining to the Pottsville Basin, and on its N. side the same either in a vertical position or pushed over into inverted S. dips. The vertical or inverted veins generally known as the Gate Beds, are evidently the same as the South-dipping coals of the S. side of the ridge folded over into N. or inverted dips.

Silver Hill Axis.—The place of origin of this anticlinal is possibly in the most Southerly of the spurs of the Sharp Mountain, which project forward towards the W. from that ridge in the region directly S. and S.E. of Middleport.

The Axis forming at first but an inconspicuous roll on the N. flank of the mountain, diverges from this ridge as it extends W., marking out the E. end of the Pottsville trough. As it ranges Westward it takes its course through the upper and lower Bare Ridges, where it intersects the Northern Tunnel. It does not reach the Schuylkill, but S. of Belmont, at the great bend of the road, the N. or vertical dips of the true Gate axis are well exposed. This extends through the hollow a little N. of Chillis's Slope, and further on becomes clearly marked in the topography by the lofty line of the Gate Ridge, which has been already traced.

On Mill Creek this Gate anticlinal may be seen on the E. side in the change of the dips, near the most Northern street of the village of Port Carbon, a little S. of the Engine Gate Vein. On the W. side of the valley it takes a position on the S. side of the crest of the ridge, and holds this relation to the summit the whole way to the Norwegian Valley at Pottsville, where it is indicated in the hollow or dimple in the end of the hill, there called Prospect Hill. On both of these valleys its precise relations to the topography and the coal-beds will be best learned from an inspection of the detailed Geological Sections of Mill Creek and the Norwegian.

Basin K, or that of the Pottsville Anticlinal and Sharp Mountain.—This extends from the S. base of Bare Ridge the whole way along the base of Sharp Mountain to the W. end of the Dauphin Basin. In the central part of its range it is deep, and contains apparently the thickest series of Coal-measures within the whole coal-field. The South Salem bed is its uppermost notable coal-seam.

Although it is not possible, in the present state of mining exploration, to trace the Gate Ridge axis E. of Bare Ridge, and unite it with that of Silver Hill, and therefore everywhere to define the N. boundary of the Sharp Mountain Basin, there can be no impropriety in considering them as

at least connected, if not continuously, by a chain of short flexures lying very nearly in their prolongation. Indeed, the truest view to take of the Gate Ridge anticlinal, and of all the other great flexures generally, is that they are rather chains of closely-linked flexures a little out of line, and usually arranged in echelon, than that they are simple undulations continuous for very great lengths. Regarding then the Gate Ridge axis of Oliver's Mine in Bare Ridge as a part of the anticlinal belt of Silver Hill, we may consider the Sharp Mountain or Schuylkill Basin as beginning in the little cove between the crest of Sharp Mountain and Silver Hill, which is drained by Harriet Run, and which we have already entitled locally the Sharp Mountain Basin *ffff*. The lowest White-Ash coals, basining out to the E. in this elevated mountain-glen E. of Dado's Tunnel, range Westward along the N. slope of Sharp Mountain its entire length, to its termination near the Susquehanna. Throughout this S. border of the basin — which, as we have already stated, is also the S. limit of the whole coal-field—all the strata, from the conglomerates of the mountain-crest to the upper Red-Ash coals at its base, observe either a nearly perpendicular dip, or a somewhat inverted one. From the E. nook, which we will call Silver Glen, the strata in the Sharp Mountain, for a few miles W., retain a N. dip, growing gradually steeper until they become vertical; but beyond the neighbourhood of Port Carbon, where the mountain exhibits signs of a transverse dislocation, the rocks are slightly overthrown, and dip steeply to the S.; this inverted condition continues the whole way to Fishing Creek Gap in Dauphin County, beyond which the beds resume their nearly perpendicular posture, which they retain nearly to the termination of the Dauphin Basin, in the Big Flats where the dip rapidly flattens, and this long trough of the Coal-measures comes to an end. The upper or Red-Ash coals occupy the lower slope of the base of Sharp Mountain, the synclinal centre of the trough and the whole N. slope of the valley, to the axis or summit of the Gate Ridge or Red Mountain.

The synclinal axis of the basin is traceable from near the mouth of Dado's Tunnel, in Silver Glen, from point to point along the immediate base of Sharp Mountain. It is seen in the tunnel E. of Port Carbon, near its mouth, and in the bottom of the Salem Slope mines at Port Carbon and Salem Hollow, where it coincides very nearly with the average course of the Schuylkill River; again at Pottsville, just S. of the town, and in a similar position at the foot of the mountain at the West Branch Gap. We meet it again on the West-West Branch, S. of the E. and W. reach of that stream, between the gap and Silverton, and may detect indications of it along the same line still farther W. There can be little doubt, indeed, that this axis coincides with the lower slope or foot of the mountain S. of the Tremont Railroad, the entire distance to the Swatara, for we detect the strongest proofs of its presence, with an inversion of its S. side, where the Swatara turns Southward to pass through the mountain. We do not catch its precise position so accurately at the passes of Rausch and Lorberry creeks, but the inversion of the Sharp Mountain strata point very nearly to its place, as a glance at the sections will show. The N. side of this deep-folded basin contains a prodigious amount of very valuable accessible Red-Ash coal, though not a small proportion of the more superficial of these moderately-inclined South-dipping seams are in a greater or less squeezed and faulty condition, unfitting them for profitable mining. On the other hand, the Sharp Mountain veins, both Red and White Ash, are, from their perpendicular or inverted positions, so crushed and difficult to mine as rarely to reward exploration.

ANTICLINALS AND BASINS BETWEEN MILL CREEK AND WEST NORWEGIAN.

Anticlinal of Mount Laffy or E *West.*—An axis very nearly, if not exactly, in the line of the anticlinal E. of Mill Creek, is seen in the N. flexure in the Primrose Coal N. of Wadesville on East Norwegian, and extends thence as the N. flexure in the same coal near Mount Laffy, being the saddle of the Old Slope Mine at Brown's on West Norwegian. This flexure flattens Westward, and disappears about 400 yards from the West Norwegian, in Brown's Colliery.

Basin of C and E West, or Basin of Mount Laffy Tunnel.—The anticlinal axis D of Mill Creek, dying out in the flank of Mine Hill, between that stream and the head of East Norwegian, the basin at the S. foot of that ridge is bounded on the S. by the axis E, or its near equivalent in the Primrose Coal. I have therefore called this the basin *C* of the axis of Mine Hill, and E West.

Anticlinal F.—This flexure of the Primrose Vein, next N. of Carey's Shaft, appears to reach East Norwegian, where, however, it has the form of simply a flat undulation on the S. dip of the Primrose Coal N. of Wadesville. It is somewhat doubtful whether it reaches West Norwegian. A rather conspicuous flexure occurs there S. of Brown's Shaft, in the Primrose Coal; between E and C it is, however, not only steeper than the flexure F of East Norwegian, but it is further off from axis E, while we should expect it to be gentler if anything in its dips, and in about the same relative position.

Basin E F.—As both the flexures E and F are feeble undulations W. of Mill Creek, this basin cannot be defined beyond East Norwegian; even there these axes are at the water-level only low waves in the general S. dip of the Primrose bed.

Anticlinal G, *Axis of Big Diamond.*—The anticlinal axis G of Mill Creek, seen there as a closely-folded flexure S. of Carey's Shaft, is probably the more open flexure S. of Wadesville on East Norwegian, lifting to the day the coal next beneath the Big Diamond. In the same range, and probably identical with it, is a closely-folded flexure on West Norwegian, just N. of the Little Diamond coal, which it seems to invert into the Big Dirt-Bed. We see the same flexure in a corresponding position on the West Branch, and again on Wolf Creek S. of Spencer's Old Slope, N. of Minersville. It is there very near its termination, if our tracing of it be correct.

Basin F G.—This basin, already traced to Mill Creek, is that of Carey's Shaft, at the bottom of which, at a depth of 400 feet (?), it contains the White-ash Mammoth coal; the synclinal axis of the basin is in the Hancock bed, near the anticlinal G, its S. boundary. On East Norwegian it is the basin of Wadesville, where it contains the valuable Primrose Coal at no great depth beneath the surface. On West Norwegian it is the basin of the N. outcrop of the N. Diamond coal, and that of the first or S. outcrops of the Peach Orchard coals. From West Norwegian we follow it across West Branch and Wolf creeks, where it is the basin of the Big and Little Diamond outcrops.

Anticlinal H, *South Diamond Axis.*—The axis H of Mill Creek, or that which bounds the Peach Mountain Basin on the N., ranges thence as far at least as the East Norwegian, where it may be seen N. of McGinnes's boring, causing a steep N. dip in the S. Diamond coal. Whether it extends to West Norwegian is extremely doubtful, no N. dips there appearing in the line of its prolongation. We have thus traced this axis from E. of the Bushy Branch of Casca William, N. of Middleport, to the Peach Mountain N. of Pottsville.

Basin G H.—The anticlinal H not being traceable continuously to the West Norwegian, and another axis, N, or that of the Dripping Spring of the W. group, originating E. of the West Norwegian centrally in this belt, it cannot be defined as a regular basin W. of the East Norwegian. It there contains near its synclinal axis the Big Diamond and Perpendicular veins, as on Mill Creek—the Perpendicular having, however, a N. dip.

Anticlinal H, *Axis of McGinnes's Boring.*—Between Mill Creek and East Norwegian, or E. of the dying-out of axis H, there rises an anticlinal flexure a few hundred feet to the S., which extends without apparent interruption a very great distance Westward—as far, indeed, as the waters of the Swatara. It shows itself on East Norwegian as the saddle at McGinnes's boring; on West Norwegian as a flexure which doubles or inverts the Green Park coal some distance N. of the Delaware Company's Slope, and on West Branch as the axis next N. of Minersville, from which point to its W. termination its course will be presently defined under another head.

Basin II h.—On East Norwegian, where alone this flexure has any existence, it is a mere undulation on the N. slope of the saddle of McGinnes's shaft, or axis I. It appears to cease before reaching West Norwegian from the dying-out of axis H, and has no existence on Mill Creek, because the other axis H does not extend so far to the E. It results, in other words, simply from an overlap of the two anticlinals.

Anticlinal I, *Axis of Big Tracy Coal.*—This anticlinal, which has its E. end N. of Middleport, is, we have already seen, a very feeble flexure S. of the Peach Mountain Basin at Mill Creek. It is discernible on both sides of East Norwegian as a very flat subordinate wave in the Big Tracy coal on the N. slope of the anticlinal I, and faint traces of it are even seen below the Chenoweth coal on Middle Norwegian, but no vestige of it can be detected when we reach the West Norwegian Valley.

Basin h I, or Peach Mountain Basin.—The general course and structure of this basin have been already stated in tracing it to Mill Creek. The East and West Norwegian Sections will sufficiently display its form and contents where it crosses those valleys; it will be seen that, passing Mill Creek, it recovers the tendency to an inverted and faulty condition S. of its synclinal axis. Its uppermost useful coal is the Peach Mountain seam, the whole of the sounder portion of which, above the water-level, has long since been wrought out, and indeed the greater part of what remained in the South-dipping part of the basin at a lower level, down even to the synclinal axis. The S. side of this basin is here very irregular from the want of continuity, and the broken condition of the flexures I and I immediately bordering it. The whole basin will be more fully described in a later Chapter.

Anticlinal I, *or Peach Mountain Axis of Norwegian.*—From Ravensdale, where the anticlinal I begins rapidly to subside to the West Norwegian, this axis constitutes the true S. boundary of the Peach Mountain Basin. We see it on Mill Creek in the hill N. of Coaquenac, also on East Norwegian, arching the Big and Little Tracy coals of the mining village at the Pottsville and Minersville road. On Middle Norwegian it separates the South-dipping Clarkson from its North-dipping counterpart the Chenoweth, and on West Norwegian the N. and S. dips of the Spohn Vein. This axis has never been successfully followed Westward from the West Norwegian.

Basin i I.—This flexure on the S. side of the Peach Mountain Basin is too trivial both in breadth and depth from Mill Creek Westward to be regarded as a separate basin. As in the instance of the anticlinals H and H, it only exists where the anticlinals I and I lap past each other,

or from a point a mile or so E. of Coaquenac to the Peach Mountain, W. of East Norwegian. Near this stream, and on both sides of Mill Creek Valley, the axis I is but a gentle wave on the N. flank of the anticlinal I. On West Norwegian, however, there intervenes between I and the synclinal line of the Peach Mountain Basin a flexure in the very line of I, which may be considered as its representative, and which presently, and for a great distance further W., puts on the same folded or inverted structure, and is the real South-bounding axis of the Peach Mountain Basin. It is the main anticlinal of Minersville, or axis O of the W. group, under which designation it will be presently traced out to its Western known limit. The uppermost coal undulated in this narrow shallow flexure is on Mill Creek and East Norwegian, the Big Tracy coal, or second below the Peach Mountain seam.

Anticlinal I, *Axis of Lewis and Spohn Coals.*—We have traced this anticlinal axis from its E. origin N. of Cwmbola to its position on Mill Creek, S. of Singley's farm. Like several of the others above enumerated, it ranges across East Norwegian, but is not recognisable at the West Norwegian Valley. On the East Norwegian it is well exposed as a sharp compressed flexure with inversion of its N. side, folding the South-dipping Mason coal back under itself as the South-dipping Clarkson. We discover proofs of its presence at the Middle Norwegian mines, or North American Company's, in the North-dipping or Perpendicular coal which occurs between the Lewis and Spohn veins, and proves them to be one and the same bed. From its retaining so steep a N. dip, it is not probable that this flexure actually ceases E. of the West Norwegian, but that it exists disguised as a South-sloping fault.

Basin i J.—This is the Spohn vein on Little Norwegian; but as we are unable to trace the anticlinal axis J further W. than Little Norwegian, it cannot of course be recognised in a separate basin even at or W. of the West Norwegian Valley. Its identification with one of the basins S. of Minersville will depend upon the continuity of the axis I, and into what W. flexure it may run.

Anticlinal K, *the Gate Ridge Axis.*—This remarkably long and straight flexure extends through the present division of the coal-field from Mill Creek along the N. brow of the Gate Ridge to the Norwegian Valley, which it passes a little N. of Pottsville. On both streams it inverts the same group of coals, and lifts to the day the self-same bed, the *Lion* or *Barn coal*, as our Sections show.

Basin J K, or Norwegian Basin.—In the district under description the basin *J K* ranges from Mill Creek to West Norwegian as a very regular broad and deep trough, its S. side dipping perpendicularly, and its N. side, without subordinate undulations, at a moderate inclination Southward to its synclinal axis. This central line of the trough ranges just N. of Pottsville, and precisely in the bed of the valley of the E. and W. reach of the East Norwegian. The highest coals here contained in it are near Mill Creek, the Salem group of Pottsville, and on Norwegian the Sand-rock beds next lower in the series.

The great continuous anticlinal flexure of the Gate Ridge, and the basin between it and the Sharp Mountain, of a length still more prolonged, having been already sketched for their entire extent, and our description of the lesser ones N. of them being now brought as far W. at least as the West Norwegian, it is proper we should enter now upon the description of the Western System of axes with which some of those already sketched are continuous. To these we therefore proceed.

WESTERN SERIES OF FLEXURES.

As nearly all the flexures of the strata W. of the meridian of Pottsville either originate in the country to the W. of the coal-field, and expire before they reach the Norwegian, or lie exclusively in the W. half of the basin, it will be expedient, for convenience of classification, to treat all these undulations as a series separate from the E. ones already described. With the exception of the remarkably continuous anticlinal of the Gate Ridge and Red Mountain, and the still more persistent one of Mine Hill, none of the W. set of waves are traceable E. to the West Norwegian; and it has been already shown that all the E. anticlinals, if we except the doubtful instance of the axis G, or that of Saint Clair, die away or become very obscure before reaching the West Branch. It is nevertheless probable that some of the saddles, especially the more folded ones of the disturbed country between the Mill Creek and West Branch valleys, do actually extend through and connect both systems, making the basins between them continuous; for it should be remarked, that what we often call separate axes are but the same lines of flexure shifted sidewise, a lateral plication of a wave becoming its principal crest: indeed, an extensive anticlinal belt not unfrequently shifts thus its crest-line many times in succession, either in a given direction, in echelon, or in a zigzag manner. I conceive that some such condition prevails to no small extent in the Peach Mountain Basin, or the much-disturbed central zone of the coal-field embraced between H H, &c. on the N., and I I, &c. on the S., and extending from the Schuylkill, N.E. of Middleport, W. as far at least as the Swatara.

The better to aid the reader's apprehension of the intricacies in the structure of the central and W. divisions of the coal-field, I shall pursue the mode adopted for the E. series of designating them by letters, and, as before, by well-known localities used as convenient synonymes. It will develop their relations more clearly to trace them from W. to E., as all the more conspicuous ones sink away in this direction. We shall advance, as formerly, from the N. toward the S. side of the basin.

ANTICLINALS.

Anticlinal L, *or Woodside Anticlinal.*—This is the most Northern flexure of the W. division of the basin S. of Mine Hill. Whether it originates on Broad Mountain W. of the Swatara, or still further W. in the Red Shale Valley of Pine Creek, has not been ascertained, but it is one of the flexures which serve to spread the Seral conglomerate in very flat undulations over the S.W. plateau of the mountain. The axis-line crosses the Swatara about three-fourths of a mile N. of Swatara Falls, and ranges thence E. to the S. base of Mine Hill near Woodside, crossing the head of the West-West Branch 1000 feet N. of the tunnel. It is here a flat roll in the Black Valley coal and the stratum next under it. How much further E. it may extend we have not definitely ascertained; it probably soon ceases altogether.

Anticlinal M.—This anticlinal, hitherto discerned only on Middle Creek, crosses that stream N. of the Swatara Falls axis, at the passage of the road to Sherman's, about four-fifths of a mile or 4200 feet N. of the axis of the Dripping Arch. Its course takes it towards the centre of the basin N. of Swatara Falls, but whether it reaches the Swatara is uncertain.

Anticlinal M, *or Axis of Swatara Falls.*—One of the most extensive and interesting saddles

of the W. series is that which ranges along the spur of the Mine Hill or Broad Mountain, which is crossed by the Swatara at its falls. This axis seems to originate in the Umbral red shale, and to cross Middle Creek in a wide but very gentle flexure in the conglomerate and lowest Coal-measures. Dipping very slowly E., and passing the Swatara Falls, it is first saddled by the lower coal-beds between the Swatara and Muddy Creek, and, still declining, is successively overarched by higher and higher strata, passing the York Tunnel, Patten's Valley, and Primrose Hill, to its termination E. of Wolf Creek, on the E. side of which it is discernible on the Minersville road. Between Patten's Valley and Wolf Creek the anticlinal part of this flexure is distinctly double, as will be shown more fully hereafter.

Anticlinal L, *or* F *West.*—Between the head of Patten's Valley and the West Norwegian ranges an anticlinal which in strictness does not belong to the W. series, but is one of the very moderately long flexures confined to the middle portion of the coal-field. On Wolf Creek it is the saddle of the Oak Hill coal or Little Peach Orchard, and on West Norwegian, the Mount Laffy axis, or that which arches the Primrose coal S. of Brown's Shaft. This anticlinal lies too far S. by several hundred feet to be in the line of axis F of Mill Creek and East Norwegian; indeed, its course would take it just N. of Wadesville. I have nevertheless called it F West, as there is a possibility that the two actually coalesce somewhere between the East and West Norwegian valleys. Its better designation, however, will be L, or the Oak Hill axis.

Basin L M.—The basin N. of the Swatara Falls axis commences W. somewhere in the vicinity of Middle Creek, but precisely how far W. the lower Coal-measures run has not been ascertained. From the Swatara E., the basin deepens somewhat rapidly, and as its S. anticinal, or that of the Falls, itself also declines in the same direction, it is obvious that it soon contains a thick body of Coal-measures. Thus Morgan's Tunnel, which lies nearly in its centre, goes on some distance N. before it cuts the first large White-Ash coal. York Tunnel lies also in this basin, but on its S. side. As we approach the valley of West-West Branch, the S. dips of the N. side of the basin becoming very gentle, and the N. dips of the S. side very steep, the synclinal axis of the basin lies more and more S. in it, until it passes through Patten's Valley, to range closer and closer to the anticlinal of Primrose Hill, until it reaches Wolf Creek, where the Swatara Falls or Primrose axis expiring, and the now more prominent undulation G, of the middle series, situated a little further S., now becoming the S. boundary of the basin, it ranges on somewhat more centrally in the trough, here that of F West, and G, until in turn the axis F West is no longer discernible E. of the West Norwegian. I am not aware that the W. limit of the Red-Ash coals within this basin has been yet discovered, but it is probably E. of the head of Muddy Branch. The section illustrating what is known of the coals of the West-West Branch will explain at a glance the positions which the several beds there occupy in this basin, as also its form; and the West Branch and Wolf Creek section will make its whole structure and contents for that district equally intelligible. A comparison of these two serves to show how rapidly it subsides towards the E., with the introduction of higher and higher coals, until it receives even a slender trough of the Kantnor Peach Mountain itself.

Anticlinal N, *or Axis of the Dripping Arch and Phœnix Mines.*—About 1800 or 2000 feet S. of the anticlinal axis M, there ranges another of even greater length, and of unusual straightness, from the Southern flank of Broad Mountain N. of Donaldson, the whole way apparently to the West Norwegian. Its W. origin is obscure, but it is distinctly developed on Middle

Creek, in the beautiful arch of conglomerate at the Dripping Spring, from whence I have chosen one of its names. Forming the S. boundary of Fisher's Basin, it ranges from the Dripping Arch, and crosses the Swatara at M'Creary's Mines N. of Tuckerville. It passes Muddy Branch at the Hecksher New Mines N. of Dewartsville, and at the West-West Branch is the flexure of the Phœnix North-slope Mine; at least, I am disposed to identify these two anticlinals. From the Phœnix Mines it ranges across Wolf Creek, as the saddle which divides the Peach Mountain coal from the Kantnor, and it appears to reach and cross the West Norwegian Valley, as a closely-compressed fold near the Big Diamond coal. Like the others, this anticlinal wave evidently sinks steadily Eastward. For the portion of the coal-field W. of the West-West Branch, it is the true N. boundary of the Peach Mountain coal-seam, though Eastward of that valley this valuable Red-Ash bed, under the name of the Kantnor Vein, not only spans it, but the axis M still N. of it.

Basin M N, or Fisher's and Kantnor Peach Mountain Basin.—The W. origin of this basin is on the S. slope of the Thick Mountain west of Middle Creek, a mile or more N.E. of Donaldson. Properly the trough has no definite W. end, but is a branch of the Donaldson Basin, gradually forking from it by the rise of the anticlinal axis of the Dripping Arch. On Middle Creek and Swatara it is known as Fisher's Basin, where, and until it approaches the cross valley of Muddy Branch, it contains only the lower or White-Ash coal-seams. On the West-West Branch, where, by the declension Eastward of both its bounding anticlinals, and their increased steepness of curvature, the basin is much deeper, though somewhat narrower, it receives, as our Section shows, a progressively increasing thickness of the upper Red-Ash coals, first the Big Diamond bed, and finally in Primrose Hill, midway between the West-West Branch and Wolf Creek, the uppermost thick one of them all, the Kantnor or Peach Mountain coal. Passing Wolf Creek, this basin narrows, and changes its N. boundary by the cessation of the anticlinal of Primrose Hill, and the introduction of the somewhat more southern axis G west. Under these new relations, as the narrow trough *G N* it ranges past West Branch to West Norwegian, where, as our Section there will show, it contains at the water-level the Little and Big Diamond and adjoining coals. The axis N not reaching the East Norwegian, this belt, as a special basin, ceases W. of that stream.

Anticlinal O, *Minersville South Axis, or Flexure South of the Peach Mountain Basin.*—An interesting flexure, or chain of nearly continuous flexures, somewhat difficult to trace, may be followed Westward from the Peach Mountain past the S. edge of Minersville, and across West-West Branch S. of the Phœnix Colliery, and the Muddy Branch near Weaver's, the whole distance to the East Branch of Swatara Creek. It is most probably an almost continuous axis from the neighbourhood of Wagner's Tunnel to the E. fork of Swatara. In its position as respects the compressed South-dipping and faulty basin, or oblique synclinal fold of the Peach Mountain seam, it represents the flexure I of Mill Creek, and the country E., and may be looked upon, indeed, as a second clear development of the same compressed wave, locally obscure between the East and West Norwegian valleys, either from the dying-out of the axis I, or from the W. portion O degenerating into a fault. Indeed, the dips which are met with on West Norwegian, S. of the synclinal axis of the Peach Mountain coal, strongly imply the prolongation of axis O eastward to this valley, as if to take up the line of the anticlinal I of East Norwegian. Some doubt exists as to the strict continuity of this anticlinal axis between the Southern edge of Minersville and the axis arching the Peach Mountain coal on the West-West Branch, some persons imagining the latter to be a prolongation of the saddle just N. of Lewis's Old Tunnel west of Minersville; but the course

of the Peach Mountain gangways, and the range of the two axes, seem to settle the question despite the intervention of a great dislocation intercepting the course of the N. flexure.

Basin N O, or West Peach Mountain Basin.—Somewhere to the E. of Donaldson, and probably to the W. of Swatara, the wide and deep basin in which that town lies between the anticlinals N and Q, forking Eastward by the introduction of the flexure O, there commences an independent basin, embraced between *N* and *O*. This basin begins to deepen rapidly after passing the Swatara, and by the time it reaches Muddy Branch, it includes almost the highest of the Red-Ash series of coals—in the opinion of many, the Peach Mountain bed itself, though this is somewhat doubtful, as cannot but appear when we reflect that 2 miles further E., or at the valley of the West-West Branch, the bottom of the Big Diamond coal, the third seam below the Peach Mountain, is only a little below the water-level, while the Peach Mountain bed itself runs out of its West Branch basin E. of the West-West Valley in the hills S. of the Phœnix Mines. It should be observed, moreover, that the basin nowhere rises Eastward from Muddy Branch until we approach the short and narrow anticlinal o, of Minersville ; for while its North-bounding axis N sinks progressively to Wolf Creek, and even to West Norwegian, its South-limiting flexure grows more and more compressed and folded in the same direction, and thereby deepens the synclinal depression of the trough. The Geological Map and the Sections explanatory of the structure of this basin on West-West Branch, and West Branch, will sufficiently indicate the contents and shape of this interesting central basin of the coal-field.

Anticlinal O, *or Minersville Axis.*—A short anticlinal axis extends under the N. part of the town of Minersville, and just N. of Lewis's Old Tunnel. It forms locally the N. boundary of the much-compressed, obliquely-dipping, or folded synclinal basin of the Peach Mountain coal; the other, or Minersville south axis, constituting its S. limit by inverting the strata on its N. flank into S. dips. The short axis o brings up the coal-seams which next underlie the Peach Mountain Vein, near the mouth of Lewis's Tunnel.

Anticlinal P, *or Griscom Anticlinal Axis.*—S. of the Minersville S. line of flexure, at a distance of from 1600 to 2000 feet, there ranges an anticlinal axis, or, more probably, a chain of several nearly continuous saddles, for a distance of many miles. I have given that axis of the belt which extends between West-West Branch and West Branch the name of the Griscom axis, from its passing through an estate of that name lying N. of Llewellyn. It has not been traced far to the E. of the West Branch, unless indeed we regard the anticlinal axis I of the West Norwegian as identical with it—a view which appears by no means improbable, when we reflect that the faulty condition of the strata S. of that flexure on West Norwegian, in the Lewis Vein, may be connected with a break in the line of the axis, jogging the W. portion towards the S. Taking it up where it crosses the West Branch S. of Minersville, we may trace it through the Griscom lands, under sundry irregularities, and a considerable deflection in its course to the West-West Branch, and we may carry it thence along the hills, though somewhat obscurely, to the Muddy Branch, and so on to the East Branch of Swatara, a few hundred feet N. of its mouth, and to a cutting in the Swatara Railroad, half a mile N.W. of the Pottsville and Tremont Turnpike. To avoid a positive identification of the portion W. of Muddy Branch with the part E. of it, I prefer to call the former P West. I believe it has not been detected W. of the Swatara.

Anticlinal P, *or Swamp Axis of West-West Branch.*—There is a small anticlinal flexure

visible to the E. of the West-West Branch, about midway between the last-described anticlinal P, and the S. Minersville flexure O. It is not detected on the West Branch S. of Minersville, and a swamp hides it in the valley of the West-West Branch, beyond which, in the absence of mining, we have not been able to find it.

Axis P P.—Another small anticlinal, possibly continuous with P, crosses the Muddy Branch about 1200 feet S. of Martin Weaver's residence; its course E. and W. is but imperfectly known. As the continuity of the Griscom axis of West-West Branch with P West of Muddy Creek and Swatara is not established by accurate tracing, it is possible that P P is the true W. prolongation of the first-named flexure, in which case P West, if it have an E. prolongation, would be continuous with the flexure Q Q N. of Minersville, the course of which across West Branch carries it only some 400 feet S. of axis J, or that of the Lewis and Spohn Vein of East and Middle Norwegian.

Basin O P, or that N. of the Main Griscom Saddle.—As we have no clear exposures of either of the anticlinal axes O or P West in the Donaldson Basin to the W. of Swatara, but only indications in the features of the ground of their extension in that direction, it is expedient to regard this basin as a middle prong or subdivision of the wide one between the Thick Mountain or axis of the Dripping Arch and the anticlinal of the Big Lick Mountain south of Donaldson. This basin, or rather this somewhat irregular synclinal belt, may be traced with little interruption, if we regard the Norwegian axis I as a prolongation of the Griscom axis P the whole way to Mill Creek. It evidently contains an extensive outcrop of the Peach Mountain coal-seam on the upper main bed of basin *N O*, known by that designation. It is apparent, however, that neither this nor any of the other uppermost Red-Ash Coals run in an unbroken manner through the length of this somewhat irregular trough; for not only does its South-bounding main axis P West, P and I, shift its position and alter its degree of flexure, but there rise within it several lesser saddles, of which P P and P are examples, each of which deflects the outcrops of its coals, and alters the course and continuity of its main synclinal line on the bottom of the basin.

Anticlinal Q Q, *or Llewellyn North Axis.*—This anticlinal, being, as just stated, nearly in line with axis J of the E. series, may prove to be continuous with it; and this supposition is the more conceivable that the axis J belongs to a flexure both wide and steep at the North America mines on Middle Norwegian, where we last behold it. The absence of any connecting evidence on West Norwegian does not overthrow so natural an hypothesis, since there is a ground notoriously blank and obscure some distance S. of the Lewis Vein through which axis J may pass undiscovered. The actual course of Q Q would seem to take it, however, too far S., or among the small Sand-rock coals of the West Norwegian.

Axis Q, *or Anticlinal of the Big Lick Mountain.*—This flexure originates Westward as a roll on the N. slope of the South-bounding mountain of the Wiconisco Basin opposite Klinger's Gap. It ranges thence through the crest of the Big Lick Mountain, saddled first by the conglomerate, and then further E. by Coal-measures, and, passing S. of Donaldson, crosses Good Spring Creek, Coal Run, and Middle Creek, and reaches the Swatara Railroad, where its arch is well exposed in a cut a few hundred feet N. of the turnpike. The flexure is here neither broad nor steep, and would seem to be near its E. termination. Though the feeble anticlinal Q seen on West-West Branch opposite the centre of the village of Llewellyn is almost precisely in a line with the axis of this flexure Q, I hesitate to regard and name them as the same, from the absence of any

N. dips in a wide space of country between them. The axis Q appears, moreover, to ascend Eastward, and not Westward, as it should, if identical with Q.

Axis Q, *or Middle Llewellyn Axis.*—As just intimated, this small flexure, faint at the West-West Branch, grows more conspicuous E. It is seen on the West Branch a little N. of the railroad bridge, in a gentle arch of sandstone, with a long succession of S. dips between it and the folded synclinal trough of the N. base of the Gate Ridge. This flexure would not appear to reach the West Norwegian. It remains for future mining developments in the district between the Muddy Branch and the Swatara to prove whether or not it is the Big Lick axis sinking very slowly down.

Basin of P, Q q.—The Western portion of this synclinal belt, or that embraced between *P* West and *Q*, may be regarded as the S. or third prong of the wide synclinal valley of Donaldson: it is not distinctly discernible on Muddy Creek, but there is a basin (that of *P* and *q*) N. of Llewellyn, into which it appears to prolong itself, unless, indeed, it is the N. half of that basin, or the trough contained between the Griscom axis P and the middle axis Q Q; in either case it extends Eastward to the dividing ground or watershed between West Branch and West Norwegian; and if Q Q be identical with J, it is prolonged much further.

Anticlinal R, *or Axis of the Little Lick Mountain.*—This conspicuous and extensive anticlinal axis enters the coal region from the Red-shale district of Williams' Valley through the head of the Kettle, and ranges along the crest of the Little Lick Mountain to Tremont, a little E. of which it crosses Good Spring and Middle creeks, trending into the N. base of the Red Mountain until it becomes apparently a component flexure of that ridge, assisting to give it the breadth and elevation it exhibits W. of the passage of the Swatara. It is to be seen in that gorge within a few hundred feet N. of the main axis of the ridge, well exposed in the cuttings of the Swatara Railroad (see Section). E. of this locality no traces of it have been detected. This Little Lick anticlinal, of which I shall speak more in detail in another place, is peculiar among the W. series of flexures in running somewhat obliquely to their prevailing course, and in subsiding much more rapidly than they do to the Eastward. It belongs, as it were, to a different system of undulations — is, in fact, simply the E. termination of one of the grand primary crust-flexures of the country beyond the Susquehanna—the flexure of the Half-Fall Mountain, or more truly of Amberson's and Path valleys; whereas the others which adjoin it in the coal-field are to be looked upon as secondary or more superficial corrugations, belonging, not to the whole depth of the earth's once flexible crust, but only to the higher strata, plicated in part, at least, by the lateral pressure due to the concave bending which formed the wide and deep trough of the Southern coal-field.

Axis R.—This is a small anticlinal axis visible on the Swatara Railroad several hundred feet to the N. of the axis R of Little Lick Mountain.

Axis R R.—This is a flexure seen on Muddy Branch, a mile or more W. of Llewellyn, and about 1000 feet S. of the Turnpike.

Axis R R R.—An anticlinal axis lying about 1200 feet N. of the main axis of the Red Ridge, ranges along the lower reach of Muddy Branch, and thence across the West-West Branch near the second railroad bridge, one-fourth of a mile S. of Llewellyn. It probably ranges still further Eastward in the N. flank of the Gate or Red Ridge, and may be one cause of the serious disturbance of the Coal-measures of that anticlinal belt.

Anticlinal S *or* K, *or Axis of Red Mountain and Gate Ridge.*—Enough has been already stated concerning the course of this remarkably straight and persistent anticlinal flexure to identify it at its various points of intersection by the streams of the country, and I shall reserve for another chapter what details I have to offer respecting its local effects upon the strata which saddle it.

Basin Q R, or that of the Big and Little Lick Anticlinals.—This synclinal trough has its W. origin in the high valley between the Little Lick and Big Lick anticlinals, at a point several miles W. of Tremont on the N. slope of the Lick Mountain; it widens and deepens Westward, and, approaching Good Spring Creek, receives the Red-Ash Coal-measures, still expanding and deepening by the recession of its South-bounding saddle R; it merges into the broader, more persistent basin *Q S*, or *Q K*, of the N. side of Red Mountain and Gate Ridge. As the middle and E. sections of this wide synclinal belt have been already sufficiently sketched, any further notice of it will be postponed to the chapter of details.

Basin R S, or that of Tremont.—This synclinal flexure, contained between the Little Lick axis on its N. and the Red Mountain anticlinal on its S., unlike the above-described basin *Q R*, contracts rapidly towards the E., though from Rausch Creek to Swatara it evidently contains its full complement of coal-seams: its rapid diminution of breadth is due to a converging of the anticlinals which confine it, both of which curve convexly as they approach. The contents and structure of this basin at the three transverse valleys of Swatara, Rausch Creek, and Lorberry, where its coal-beds have been somewhat carefully opened, are clearly shown in our Sections of those several ravines. As will be observed, it contains at Tremont not fewer than twelve distinct beds of coal above the water-level, all of which belong to the Upper or Red-Ash series. At Rausch Creek, the main bed of coarse conglomerate at the bottom of the Coal-measures is uplifted above the water-level to a high elevation in the axis of Little Lick Mountain; and S. of this, about 2000 feet, the Big White-Ash coal of the W. end of the coal-field has its outcrop, with a gentle S. dip. It again nearly reaches the water-level in the anticlinal axis of Red Mountain; thus the lowest Red-Ash coals extend Westward from Tremont in successive superposed basins to the brow of the plateau looking down into the ravine of Rausch Creek.

Axis s, *or Anticlinal of Silvertown Colliery.*—This is the most Southern flexure hitherto detected in the W. division of the basin. It has not been traced beyond the locality whence it takes its name. Its relations to the main folded anticlinal S are well exhibited in the Section illustrating the West-West Branch.

CHAPTER II.

FIRST OR NESQUEHONING AND PANTHER CREEK DIVISION OF THE DISTRICT BETWEEN THE LEHIGH AND TUSCARORA.

In the detailed description of the Coal-measures of the Southern Basin, upon which we now enter, the numerous natural belts, anticlinal and synclinal, will be treated in the order observed in the sketch of the anticlinal axes presented in the preceding Chapter. Not only will the

axis-lines of the flexures—that is to say, the tops of the saddles and the bottoms of the basins—be traced with all the exactness which the information collected will permit, but the individual coal-seams will be treated of, their positions and relations to the saddles and basins pointed out, their outcrops followed where this is practicable, and their order of superposition, distances from each other, and respective thicknesses carefully made known. As a detailed written account of every measured section of the coal strata, printed in this work, would make the text unnecessarily voluminous, and as all the information that could be thus set forth in writing is embodied in a clear and condensed shape in the accompanying engraved Sections and Diagrams, possessing a suggestive power which words cannot aspire to,—as all the elements of the composition and structure of the Coal-measures are there displayed even to the nicest features in the curvatures of the strata, their degrees of dip or slope, the measured intervals which divide the coals, and the subdivisions of the coal-seams themselves,—it is highly expedient that the reader should constantly consult the appropriate drawings while perusing the text. He is also earnestly recommended to resort frequently to the Geological Map, to acquire, in connection with the Sections, clear conceptions of the districts under description, and of the precise positions of the localities referred to.

The great extent and complexity of feature of the coal-field, make it expedient to consider it under subdivisions, even though the limits of these are somewhat arbitrary. I have already shown that it admits, upon a large scale, of a division into five somewhat natural districts; and I shall proceed, in the first place, to review the structure and contents of the most Eastern of these, or that which extends from the point of the basin near the Lehigh to the head-waters of the Schuylkill, where it loses its slender and simpler structure, and begins suddenly to expand and grow complex. In connection with the tracing of the undulations, and of the groups of coal-beds lifted and depressed by them, numerous details, especially of the more permanent class, will be presented concerning the conditions under which the coals occur at all the more important mining localities where they are now wrought, or have been opened. Much description of the interior workings of the mines, collected in the progress of the Survey merely as data towards the identification and mapping of the saddles and basins, and the tracing of special coal-veins, will be omitted, inasmuch as such statistics are constantly changing, and are, moreover, of an interest too purely local to justify a permanent record.

EASTERN END OF THE COAL-FIELD, ESTATES OF THE LEHIGH AND LITTLE SCHUYLKILL COAL COMPANIES.

Beginning of the Coal Strata.—The general form of the E. division of the basin, or that which lies between the Lehigh and Tuscarora, is, as we have seen, that of an acutely-tapering synclinal trough. It terminates, as all similar basins do when enclosed by ridges of any of the harder rocks, in a high prow or elongated oval summit, formed by the union of the two mountain monoclinal barriers of the basin. In the instance before us, the knob in which the coal-basin commences is not absolutely symmetrical as respects the general synclinal line of the trough, but is situated almost wholly to the N. of it. It is, in fact, the prolongation of the crest of the Northern or Locust Mountain, that of the Southern or Sharp Mountain being here broken down. Thus, while the massive conglomerate beds of the Locust Ridge extend into this termi-

nating summit, those of the Sharp Mountain outcrop lower down on the steep S. slope, only the higher ones appearing above the level of the Back Track Railroad. This feature is the result of a want of symmetry in the dips of the outcrops of the conglomerate, that of the Sharp Mountain being almost vertical, and everywhere much steeper than that of the Locust Ridge.

Eastward from this highest knob of the basin, and almost exactly in the *synclinal axis*, there is a partially-detached lower summit called Mount Pisgah, inferior in height to the loftier one by perhaps 100 feet, and separated from it by a narrow neck or *col*, depressed 60 or 70 feet below the level of Mount Pisgah. This last-named hill is formed of the lower member of the conglomerate formation, while the neck which joins it to the main mountain is excavated in the softer sandstones composing the central group. Mount Pisgah is therefore the extreme E. point of the Seral conglomerate, the very lowest layers of which may be seen, near their contact with the superior beds of the Umbral red shale, about one-third of the way down from the summit Eastward, exposed in the cuttings for the inclined plane which rests on this slope of the mountain.

From what has just been said of the positions of the two bounding ranges of the conglomerate, it is obvious that the end of the included Coal-measures is not in the terminating knob, but on the S. slope of it. Here, in fact, the point of the basin has been obliquely shaved away on its S., or rather S.E. side, so that it does not end by the closing round it of the conglomerate, but is nipped abruptly off with the destruction of its S. barrier. This greatly-denuded point of the trough of the coal-rocks may be traced from the spot where some coal has been opened in it, just W. of the little reservoir, Eastward above the level of the railroad for several hundred yards, to where all signs of the Coal-measures vanish, on the S. flank of the high knob.

Westward from the reservoir, the waters of which are manifestly supplied from the drainage of the coal-rocks overlying the conglomerate, the S. border of the basin becomes better supported by the rising of the Sharp Mountain barrier of conglomerate. First the upper or N. rib of this formation assumes its proper place on the margin of the basin, in the form of a narrow craggy ledge of very steeply North-dipping strata. This ledge becomes conspicuous at about two-fifths of a mile W. from the reservoir, from which point W. the basin, ceasing to be obliquely truncated, loses its irregular character of a mere denuded terrace, subordinate to the S. slope of Locust Mountain, and takes its natural position between barriers of nearly equal elevation on its two borders. At the distance of nearly half a mile further, the lower or S. rib of the Sharp Mountain conglomerate likewise gains in due succession its proper elevation, and from this point forward forms the outer crest and brow of the ridge, which, thus strengthened and augmented, assumes and maintains an elevation equal to that of the crest of Locust Mountain. The Sharp Mountain rocks throughout their whole range, from E. of the little reservoir to the meridian of Nesquehoning, present an almost perpendicular dip, seldom inclining less than 85° N. Those of the Locust Mountain, from the terminating knob of the basin to Nesquehoning Notch, and indeed for a far greater distance, dip S. at an angle which seldom exceeds 60°, for the upper or S. strata, and by the curving of the whole mass is as low in many places as 45° and even 30°, on the N. or lower layers. Towards the E. end of the basin, in the vicinity of the little reservoir, the dip on this strike appears to be at its maximum, the whole synclinal trough lying here evidently closely folded. It is to the greater steepness of the Sharp Mountain strata, compared with those of Locust Mountain, that we must ascribe the greater denudation or

cutting-down of the former ridge by the waters which once rushed over the basin from the N. The depression at the reservoir, which separates the knob from the main crest of Locust Mountain to the W., is likewise the result of the same Southward-moving current.

The E. end of the basin, embracing the Coal-measures from the reservoir W. for nearly one-third of a mile, is not at all basin-shaped or trough-like in its profile, but is simply an elevated flat, bounded by the Locust Mountain and Sharp Mountain ledges of craggy conglomerate, which rise above its plane not more than 40 or 50 feet. But from the point just specified, the surface included between these barriers takes a hollow form, and soon assumes the curve of the point of a beautifully-modelled spoon. As we advance half a mile or so further W., where the two borders of the trough become more nearly straight, diverging but slowly from each other, the whole valley tapers in the form of a gradually-expanding shallow boat, with low but steep bulwarks, and the bottom sloping gently on both sides toward the keel. Such is its contour in the vicinity of the Mauch Chunk Tunnel, and for 1½ miles W.

From the point now reached the basin assumes new features. The Locust Mountain or N. barrier, holding its rectilinear course to the Kitchen Gap at Nesquehoning, becomes steeper on its S. flank, and by a stronger denudation more terraced. The central deeper bed of the valley containing the Kitchen Creek is now more profoundly excavated, and approaching the meridian of the sudden elbow of the stream where this leads Northward, it is sharply ravined, the whole surface presenting here the cross section of the bottom of a great ship, furnished with a very deep keel.

Anticlinal Axis A, or Rhume Run Anticlinal.—About the point where these features begin, or nearly 1½ miles W. of the Old Tunnel, the Sharp Mountain assumes a significant feature, bulging in a broad knob, and bending somewhat more Southward in its trend to the W. This point appears to mark the commencement within the basin of an anticlinal flexure of the strata, which extends hence to the N. side of Panther Creek, and is not lost until we reach the meridian of Dry Hollow, on a position yet further W. The influence of this saddle in the rocks, which I shall call the Rhume Run Anticlinal, is a very important one upon both the topographic features of the basin and the distribution of its coal-beds. It divides the general coal-field between the Sharp and Locust mountains into two subordinate basins, the Northern being the prolongation of the single Eastern one, which we may name the Mount Pisgah and Hell-Kitchen Basin, while the Southern is that which contains the main waters of Panther Creek, the name of which I propose for convenience to apply to it. This latter has for its S. boundary the crest of Sharp Mountain, and the anticlinal spur into which this prolongs itself at Summit Hill, and as far W. as Dry Hollow. The Northern or Kitchen Run Basin is deeply intersected transversely by the ravines of both the Kitchen Run and Rhume Run, which discharge their drainage through their respective notches in Locust Mountain, near Nesquehoning. The S. subordinate basin, originating, as was indicated, about a mile E. of the position of Nesquehoning, has here a high table-land surface, which extends W. as an elevated skirt from the base of the crest of Sharp Mountain, all the way to the S. head-ravines of Panther Creek — its only obvious indentation being a ravine opening N.E., which contains the S. prong of Rhume Run. Between the ravines of Rhume Run and those of the sources of Panther Creek, the whole general basin, including the central anticlinal and the two synclinals, is filled up to one even level contour, presenting large breasts of coal in the two subordinate troughs.

Course of the Rhume Run Anticlinal traced.—This well-marked anticlinal axis defines itself very beautifully at sundry points along its course. We first encounter it going Westward, in the long Nesquehoning Tunnel (No. 1), where it causes the steep N. dip of the N. vertical seams, and other coal-beds next S. of this. Traced to the ravine of Rhume Run, the very axis itself is seen exposed in a grand saddle of coal, long ago laid open to view, at what is called the Fifty-feet Vein, the coal-bed being here that which elsewhere in this locality is known as the Twenty-eight-feet Seam, the actual thickness of which is, however, generally 14 or 15 feet. (See the Plate, which presents a view of this fine saddle of coal as it was to be seen in 1840, when the mine was actively wrought.) At a lower level than this arch, the two dips of the twenty-eight feet coal are seen in the Rhume Run Tunnel, or that called No. 2 of the Nesquehoning Mines. On the W. side of Rhume Run the axis is well expressed in a jutting hill or knob, which rises here immediately in the line of the great arch of coal. Following the course of the anticlinal through the table-land or watershed of the valley, it is first indicated in the wide gentle central ridge which starts from Rhume Run in the hill just mentioned, but at the very watershed it is scarcely marked at all upon the surface. From this high flat, Westward, it may be very distinctly traced in the crest of the long symmetrical ridge which this plateau sends forward between the ravines of the Middle and N. branches of Panther Creek. The exact place of the axis is revealed at the extremity of this spur, where the strata, crossing the stream, are exposed between the mouth of Tunnel No. 6 and the Coal-Breaker connected with the mines here. Its position is about 400 feet S. of the tunnel. The axis is again exposed nearly a mile from this point in Tunnel No. 7, close by its mouth, and is distinctly and for the last time revealed in Tunnel No. 8, about another mile still further onward. From this point forward we may see in the form of the surface the prolongation of this straight and regular anticlinal for yet a mile or more Westward, beyond which it is at present too vaguely indicated to be traceable. That this anticlinal does not reach the Little Schuylkill, nor even the ravine of the Greenwood Tunnel, will be quite obvious to the reader upon his merely inspecting the sections at those places. The undulation evidently smooths itself out at the foot of the Locust Mountain, somewhere opposite the point of the long spur of Summit Hill, a mile or more Westward from Coaldale.

A, *Panther Creek S. Anticlinal, or Subordinate Axis of Panther Creek.*—I must here observe that we have indications, both in the topography and the dips of the strata at a few points, that there exists a second parallel and smaller anticlinal a thousand feet or more to the S. of the main one already traced. It appears to start from the high flat ground S. of Rhume Run Gap, and pass through the Southernmost ravine of Rhume Run, thence through the watershed and the spur which this sends off between the Southern and middle forks of Panther Creek, and thence along the brow of the ridge which bounds the immediate valley of Panther Creek on the S., as far as the base of the Panther Creek inclined plane No. 2. Thus the main stream of Panther Creek would seem, in the part of its course opposite Summit Hill, to flow along a central small synclinal trough midway between the two approximate anticlinals.

This axis is intersected in Tunnel No. 9 about 300 feet S. of its entrance, where it exposes excessively steep dips, and is partly compressed. The anticlinal here coincides very nearly with the summit of the ridge, the height of which about Panther Creek approaches 100 feet. (See Section of the Coal-field from Sharp to Locust mountains through Summit Hill, Plate VI.)

B, *Summit Hill and Tamaqua Anticlinal.*—The next great feature, structural and topographical, which we encounter in our progress Westward along the coal-field, is the broad and well-marked

Anticlinal of the Summit Hill.—I have already defined this to be approximately but not strictly in the prolongation of the great anticlinal of Mine Hill, which here, at the Summit Hill, passes out of the basin through its S. barrier of conglomerate. The axis of this bold flexure is first developed to the Eastward in the high expanded summit of Sharp Mountain, which is called Mount Jefferson, where the dips on both sides of the axis in the arch of the Seral conglomerate on the crest of the mountain are extremely gentle. The whole mountain at this broadest point embraces indeed not only the anticlinal arch, but the extreme end of the basin of the E. Mine included between this anticlinal and the crest of Sharp Mountain. In its course Westward this anticlinal holds up the conglomerate in a gradually-contracting mountain-spur for a distance of 1½ miles as far as the W. edge of the village of Summit Hill, past which spot, a little W. of the crossing-point of the main public road, the axis is overarched by the Coal-measures, the Great Surface Mine, or open quarry of coal of the Lehigh Company, here commencing. From this place the ridge-line of the flexure is traceable through the old mine, with everywhere a dip of 40° or 45° on its S. side, and a steep one of 75° or 80° on its N., to where the two grand outcrops of the gigantic coal-bed unite, and saddle the axis about 1000 feet W. of the mouth of the Slope mine called No. 2. The precise position of the axis is under the N. edge of the village of Summit Hill, again about 100 feet S. of the Catholic chapel, and again almost exactly at the Breaker House of the Great Slope Mine. From this last-named spot the anticlinal and the spur which it sustains point downward in their W. course, until the axis crosses the ravine called Dry Hollow. Its course thence is high on the N. slope, and along the crest of the Dry Hollow spur or ridge, within which it is intersected by the Dry Hollow Tunnel at a point about 700 feet in or Southward from the mouth. From the W. part of this high ridge, which, for a certain distance, almost coalesces with the N. flank of Sharp Mountain, the further course of the anticlinal for half a mile is a little vague, but we recover traces of it immediately on crossing Panther Creek south of the ravine of Greenwood Colliery, where the axis passes between the public road and the Coal-Breaker. Thence to its exposure at the Little Schuylkill its position may be approximately made out by its topographical indications, in the absence of definite exposures. On both sides of the river I have detected the exact place of the axis within a possible error of a very few yards.

It will be observed, on inspecting our Section of the basin at the Little Schuylkill, that three anticlinals are indicated. The existence of all of these is obvious from the directions of the dip in the rocks. The S. one is the Mine Hill axis, and the N. one the prolongation of that of the Summit Hill or Sharp Mountain anticlinal. As, however, the interval at the river between the Northern and Middle one is only 650 feet, and that between the Middle and Southern does not exceed 850 feet, all three may be regarded as but undulations in one main anticlinal; and our view will not err either in its practical bearings or its theoretical soundness, if we consider the Mine Hill and Summit Hill flexures as essentially one continuous line of uplift.

The Mine Hill axis, in its E. extension crossing the Little Schuylkill on the S. edge of the village of Tamaqua, seems to be prolonged Eastward from the river for a short distance at least, but how far, it has been impossible to ascertain. This axis is evidently already very faint at Tamaqua, as the section there will show, and it is possible that it does not pass the river more

than a mile or so before it ceases altogether ; yet there are indications that it reaches the Sharp Mountain S. of the Great Summit Mine.

SYNCLINAL BELTS OR BASINS.

Having traced with sufficient minuteness the anticlinal flexures of the E. end of the coal-field as far W. as the Little Schuylkill, let us, before proceeding further, describe the subordinate basins which they enclose, and the Coal-measures which lie within them.

Basin A, or Synclinal Trough of Anticlinal A *and Locust Mountain.*—This Easternmost subdivision of the coal-field, bounded on the N. by the Locust Mountain, and on the S. by the anticlinal axis A, originates, as we have seen, on the S. slope of the terminal mountain-knob of the coal-field, near the little reservoir above the railroad. It deepens and widens Westward between Locust and Sharp mountains, to the place of the commencement of the anticlinal axis A, on the shoulder of the last-named ridge, beyond which it follows the N. side of the valley, at the base, and in the S. slope of Locust Mountain to the cessation of axis A, where the trough merges into the wider basin *B*, contained between the Locust Mountain and the anticlinal axis B of Summit Hill, prolonged thence to Newkirk. Throughout its entire length, indeed to the Little Schuylkill, and still further, the Coal-measures of the N. side of this straight and regular trough have a rather uniform undisturbed dip S. of from 45° to 60°. They ascend in many places nearly to the top of the S. slope of the Locust Mountain. Some of the lower coal-beds, especially the Great Summit stratum, being very thick, their lines of outcrop are distinctly expressed in many places by slight, nearly level indentations along the flank of the mountain, looking, under the slanting Western sun, like ancient half-effaced beaches, or long-neglected roadways. These benches on the mountain, as they are called, are particularly distinct opposite Summit Hill. A sketch here introduced (see Plate) illustrates well their features in that part of the basin, when beheld late in the afternoon of a summer's day, or, better still, when the snows of winter cover all the lesser inequalities of the surface and all confusing diversities of colour, and display only the softer contours of the surface.

From the E. head of the basin for nearly 2 miles W. to a bulge in the Sharp Mountain, which marks the commencement or passage of the first anticlinal axis, the Coal-measures of the S. side of the trough possess a nearly vertical dip, like that of the conglomerate of the mountain. This E. end of the basin, though not traversed by any yet known anticlinal axis, shows a considerable amount of disturbance, especially towards its centre, as might be inferred from the excessive steepness of the strata, and their confining walls of conglomerate. The Lehigh Company's Old Mauch Chunk Tunnel, as it is called—the first ever constructed in the coal region—lies nearly one mile W. of the point of the basin. It perforates the entire thickness of the conglomerate of the Sharp Mountain, and apparently reaches the Big coal of the basin, the position of which is nowhere far above the conglomerate, with seldom more than two comparatively thin coals between them. The large coal, however, is in a thoroughly squeezed and jumbled condition, and wholly unfit for mining. It is evident, indeed, that it occupies merely the synclinal axis of the basin, and that the central depression of the trough contains not a simple synclinal curve, but a succession of close and confused foldings of the superficial strata—an almost invariable feature towards the ends of those coal-basins which exhibit a sharp or steep flexure of the rocks.

Indeed, it is not conceivable that the soft Coal-measures, the uppermost formation, should be otherwise than greatly crushed or plicated, compressed as they must have been at the steep uptilting of the far less yielding formations which underlie them. It is not probable, therefore, that this extreme E. division of the coal-field, the end of basin *A*, will afford much coal in a sound enough condition for working; there is, however, a fair prospect of a good body of tolerably sound coal W. of the tunnel, towards the Hell-Kitchen Gap at the S. base of the Locust Mountain, where the dips do not exceed 60°. Near the line of the tunnel, the Lehigh Company caused a deep cross-trench to be cut not far from the synclinal axis of the basin, but the coal—probably the large bed of the Nesquehoning mines called Twenty-eight Feet Bed, but actually measuring 15 feet—proved to be in a thoroughly crushed condition. Another cross cut, some 400 feet W. of the line of the former, also shows an apparently large mass of squeezed coal; and a third lesser one, 300 feet S. of this, was made with no better success. A coal 10 feet thick at the outcrop was opened near the line of the tunnel, on the S. edge of the very crest of the Locust Mountain.

NESQUEHONING MINES.

These mines are part of the coal estate of the Lehigh Company, and are situated about 4 miles W. of the E. point of the basin opposite the mining village of Nesquehoning. The Locust Mountain—sometimes erroneously called the Nesquehoning Mountain—is here cleft by two deep notches; the more Eastern of these, called the Hell-Kitchen Gap, from the excessive ruggedness of the ground, discharges the Kitchen Run, which drains all the E. end of the basin. The more Western, half a mile distant, is called the Rhume Run Gap, discharging a stream of that name which heads W. and S. a mile or more distant against the sources of Panther Creek.

The Coal-measures of the basin *A* we are describing are deeply cut and well exposed in the ravine of Rhume Run, and have been for many years extensively mined for their coal, and I propose to show, with the aid of a Section, as far as the developments and the data collected will permit me, the particular type which the Coal-measures here put on. As the Section speaks for itself, showing the horizontal distances between the outcrops of the principal coal-beds, their angles of dip, and their horizontal thicknesses, a detailed description of it will not be necessary.

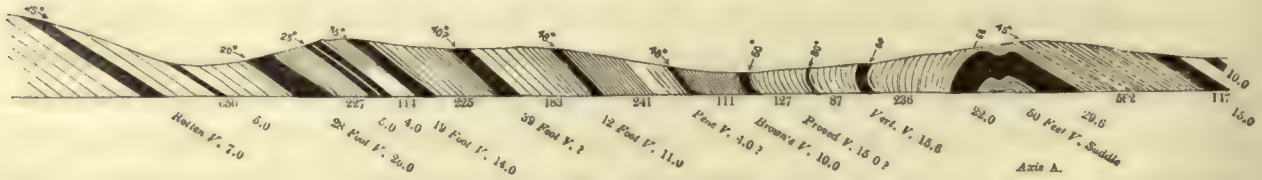


FIG. 138.—Section of the Coal Strata at Rhume Run, looking E.

The measurements were made in 1840, when many of the developments were less obscure than, from dilapidation of the older workings, they are at present; but it should be observed that some additional facts have probably since come to light, of a nature to modify slightly the results here presented. The precise position of the synclinal fold has not, I believe, been ascertained, but it is probably somewhere between the 12-feet coal dipping S., and the apparently inverted coal called the Pencil Vein. We revised the ground in 1852, and found some new developments, requiring us to modify our previously carefully-gathered notes.

Two long tunnels have been cut across the strata, intersecting in all nineteen strikes of coal, but some of them under three repetitions, from the circumstance that they cross the anticlinal axis A from the N. basin to the S. one next the Sharp Mountain. These tunnels cut seven separate coal-seams, of diameters from 3 to 17 feet; which, when originally opened at their outcrops, appeared to be far thicker, and some of them are still designated by their first-imputed exaggerated sizes. Nevertheless their dimensions at this locality are unusually large, the amount of coal in the first few hundred feet of the Coal-measures rivalling that to be found anywhere in the general coal-field. Besides the seven workable beds here enumerated, the outcrops of two or three others have been opened, showing thicknesses of 2 feet and less

The following tables, politely furnished by the officers of the Lehigh Company in 1853, contain the most authentic data procurable, respecting the thicknesses and workable capacities of the several seams. Their distances asunder are not given, but these are approximately presented in the engraved section, constructed from our earlier measurements.

COALS IN TUNNELS Nos. I. AND II., NESQUEHONING MINES.

TUNNEL No. I.

No.	Name.	Horizontal Thickness.	Thickness at right angles.	Estimated working Coal.	Observations.
1	Rotten vein				
2	...	...	3 feet		
3	28-feet vein	22 feet	14½ „	say 9 feet	Identical with No. 13.
4	5 „ „	...	4 „	„ 4 „	„ „ 11 or 12.
5	19 „ „	29 „	17 „	„ 8 „	„ „ 10.
6	39 „ „	26 „	15 „	„ 8 „	„ „ 9.
7	12 „ „	16 „	12 „	...	„ „ 8.
8	Pencil vein	14 „	...	...	„ „ 7.
9	Brown „	14 „	...	...	„ „ 6.
10	N. vertical vein	18 „	16 „	„ 8 „	„ „ 5.
11	6-feet vein	6 „	...	...	
12	4 „ „	4 „	...	„ 3 „	
13	50 feet N. dip	25 „	...		
14	50 feet S. dip	31 „	...		
15	3-feet vein	4 „	...		
16	10 „ „	18 „	...		
17	26 „ „	26 at bottom of tunnel.	average 13 feet.		
18	14 „ „	14 „	...		
19	11 „ „	11 „	...		

TUNNEL No. II.

10	N. vertical				
11	2½-feet vein	...	2½ feet		
12	2½ „ „	...	2½ „		
13	50 feet N. dip	27 feet	23 „	say 9 feet	
14	50 feet S. dip	38 „	30 „		
15	2-feet vein	...	2 „		
16	1½ „ „	...	1½ „		
17	S. vertical	12 „	...		
18	A new vein.	...	5 „	„ 2½ „	

Comparing the data presented in the first Table with the engraved Section, it will be observed that the latter exhibits a thin coal, called the Proved Vein, between Brown's Vein and the North

Vertical, whereas no such appears in the list of those cut in the tunnel. On the other hand, two coals—the 6-feet and the 4-feet seams—occur in the tunnel between the North Vertical and the great arching coal called the Fifty Feet. Our Section, however, shows these on the S. side of the great saddle, and in their right position above the so-called Twenty-eight Feet Vein, of which the saddle is but the anticlinal uplift; there is therefore no discrepancy except in the introduction of the thin coal between the North Vertical and Brown's.

How far along the basin to the Eastward each of the seven main coals, intersected by No. 1 Tunnel, extends before it is finally lifted out in a point by the continuous rising of the whole trough, it is impossible, in the absence of extensive mining and shafting in that direction, to ascertain, but it is pretty obvious that the uppermost can hardly pass the ravine of the Kitchen Run: the underlying seams must, however, extend in broad and regular breasts between the centre of the valley and Locust Mountain a good distance E. of the ravine; the lowest of the large ones—the so-called Twenty-eight Feet Vein, or third in the ascending order—reaching to the Mauch Chunk Tunnel, but much crushed towards its E. termination, as we have already seen. It is a point of interest to know how far this large coal, No. 3, continues to span the anticlinal axis Eastward from the tunnel. It is exposed, as we know, in the ravine of Rhume Run, where it exhibits the remarkable saddle represented in the sketch (see Plate); and as our Table shows, it is cut in both the tunnels. The rise of the axis most probably brings it to the day somewhere opposite the turn of the Kitchen Run towards the N. It is not probable that either this or any of the overlying coals will be found to contain on their N. dip, either along the anticlinal axis or the Sharp Mountain eastward of Rhume Run, any considerable amount of sound merchantable coal.

The coal-seams of the Nesquehoning mines are for the most part wrought by "drifts" or "levels" leading E. and W. from the tunnels following the course of the beds. Some drifts are also carried in from the water-level of the ravine, and the Big Seam has also been mined by a slope or an inclined plane, with railway-tracks laid on the slanting floor of the coal-bed, and with a stationary steam-engine as the lifting power, after the manner prevalent in the coal region. From the mouths of the drifts the coal is conveyed by short branch-roads to a central or trunk railroad Northward across the strata towards the opening of the notch in the mountain, where a long inclined plane, descending at an angle of 6°, overcomes the declivity of the ravine, and conveys the coal to another railroad at the village of Nesquehoning, by which it is transported to the Lehigh Navigation at Mauch Chunk, a distance of about five miles.

Though we cannot determine strictly the position of the synclinal axis of the basin, the evidence preponderates for placing it just N. of the Pencil Vein. Upon this interpretation of the Section, the Third or Twenty-eight Feet Vein, so-called, and the so-called Fifty-Feet Vein, are but different outcrops of one and the same bed. This is manifest from their agreement in thickness. Upon the same hypothesis, the Fifth or Nineteen-feet Vein by name, actually 17 feet thick, has its other outcrop in the N. vertical vein; and the Sixth or so-called Thirty-nine-feet Vein, the real thickness of which has been ascertained in the tunnel to exceed 15 feet, is the equivalent of the Brown Vein; while the Twelve-feet Vein and the Pencil Vein are the two outcrops of the uppermost, separated by the synclinal axis or fold. Upon this view, the counterpart of the double bed, sometimes called Rowland's Vein, which next overlies the third or main South-dipping coal, is the fourth or 5-feet seam near the mouth of the tunnel.

COAL-SEAMS OF THE NESQUEHONING MINES.

I proceed now to give a description of the several coal-beds.

No. 1. *Rotten Coal.*—This is apparently the lowest coal in the series, though its distance above the assumed top of the Seral conglomerate has not been definitely ascertained. Its total thickness is about 7 feet, of which 5½ feet are coal. This coal burns well enough, but is crumbly and unsaleable. It resembles much, both in its aspect and fracture, the corresponding lowest bed of the Tamaqua mines. Where mined, the roof or top slate has not been firm, but shaly, though the floor or bottom slate was strong and hard. This was mined chiefly on the W. side of the ravine, where there were two drifts, one on a level with the railroad, and the other about 60 feet above it. But this mine is now no longer prosecuted. The slope of the hill on the E. of the ravine is such as to give it too little breast there to make the mining of it profitable, even if the coal had proved of a quality suitable for the market. Its dip is 25° S., and its strike is nearly E. and W.

No. 2. *Two Thin Coals.*—Between the Rotten Coal and the Main Lower Coal, two thin seams are known, but their distances from it are not accurately ascertained. One showed at the outcrop about 15 inches thickness of crushed coal; the other was also very narrow, but its real dimensions had not, at the date of our first observations, been recorded by the miners. Subsequently one of them has been mined near Tunnel No. 1, and, according to the table, measures 3 feet.

No. 3. The *Main Lower Coal,* called the Twenty-eight-feet Vein, has its outcrop 650 feet to the S. of the Rotten Coal, and is separated from it by an actual thickness of 222 feet of coarse sandstone and slate. The total width of this bed, measured horizontally, including its benches of slate, is about 22 feet, though, from the disturbances in the dip, it is somewhat variable. It consists of several portions :—

1. Upon the bottom slate rests a layer of slaty coal dirt, ...	1 foot.
2. To this succeeds the lower bench of coal, usually 7 feet, but occasionally 13 feet thick, .	7 feet.
3. Next a slate of variable size, increasing, as the drift advanced W. of the mouth of the mine, to	4 „
4. Above this a layer of bone-coal, or slaty coal, ...	5 „
5. And capping the whole, an upper bench of coal, never more than	5 „
	22 „

The actual thickness is 14½ feet in the tunnel, and the amount of marketable coal is, on an average, 9 feet.

The original mine was on the W. side of the ravine. The bed was entered by three drifts in all, with a difference of level of 40 feet between each two. Only the lower one was persevered in. In one of the upper ones, the top and middle slates cut out all the coal. When first entered, the bed preserves for 100 yards an average thickness of 25 feet, having a few seams of slate, but yielding a very good coal. At about that distance a fault or curl in the top slate was encountered for a short distance, and beyond it the coal has never been as firm and regular as previously. The middle slate, which now divides the bed into two benches, was originally but a few inches thick ; but passing the fault, it swelled to the dimensions already stated. At the termination of 700 yards the drift ends in 6 feet of coal. The disturbances in this mine were generally in the top slate.

As with nearly all the beds at this locality, the dip is not constant. At the mouth of the drift it is 20° S., but further in it increases, and occasionally is perpendicular; at 260 yards in it is 50° S., and at 700 yards 40° S.

No. 4. *Rowland's Coal*, or the double bed, outcrops 227 feet to the S. of the Main Coal, being divided from it by 77 feet of rock. This bed consists of two seams of coal separated by 3 or 4 feet of slate. The lower bench of coal was opened on both the E. and W. sides of the ravine, and measured 4 feet of very inferior coal, and was therefore never followed; but the upper coal, which was likewise entered in both directions, yielded on the E. side, where it was soundest, about 5 feet of good coal with no slate. In the tunnel it contains 4 feet of good coal. On the W. side it was more disturbed, there being a succession of rolls for the first 150 or 200 feet, beyond which the bed was regular, with a dip of 25° S.; whereas near the entrance of the drift the dip is 60° S.

It was stated to us by the intelligent superintendent of the mines, that a little to the S. of the lower bench of this double bed, he met with the largest bed of *iron ore* seen in these mines. Time had obliterated the freshness of the excavations, and we were therefore unable to ascertain either its amount or quality.

No. 5. The *Nineteen-feet Coal*, the real thickness of which in the tunnel is 17 feet, has its outcrop about 114 feet to the S. of the Double Vein, with an actual thickness of intervening strata of nearly 57 feet. Where this bed was opened on the E. side of the ravine, it consisted, beginning with the bottom, of, 1st, about 2 feet inferior coal; 2d, 6 inches of slate; 3d, 4 feet of coal; 4th, a few inches of slate; 5th, from 2 to 3 feet of coal; and 6th, the remainder of the bed, soft or dirty coal. On the W. side of the ravine the bed was opened at a higher level; but here a roll, or rather a small anticlinal bulge of the whole bed, occurs, upon both sides of which rather good coal was obtained: but all mining upon this coal was subsequently abandoned. This bed is not very regular in its course or dip. The average dip is 35° S.

No. 6. The so-called *Thirty-nine-feet Coal*, the true thickness of which is about 15 feet, is distant from the last-described bed 228 feet, and overlies it by 137 feet of interposed slate and sandstone. On the W. side the bed exhibits an anticlinal dip in the drift, with the coal 10 feet thick on each side of the axis. Extending the drift along the Northern or steepest leg of the arch, the dip suddenly changes from 35° or 40° N. almost to perpendicular. Believing that the coal must rise again, the superintendent of the mines caused a tunnel to be driven Northward through the top slate, and thereby reached, at no great distance, a steep South-dipping bed of coal, 23 feet in thickness, much of which was of good quality.

The two following diagrams, one a section of the bed at this point, and the other a ground-

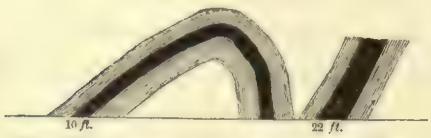
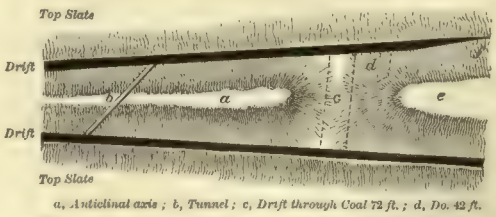


FIG. 139.—Section of Coal, No. 6, Rhume Run.



a, Anticlinal axis; b, Tunnel; c, Drift through Coal 72 ft.; d, Do. 42 ft.
FIG. 140.—Ground-Plan of Old Mine in the No. 6 or Thirty-nine-feet Coal at Rhume Run.

plan of the mine, are instructive as illustrating the remarkable local alterations in thickness which coal-beds often present where they have been subjected to violent contortion and disturbance,

No. 7. The *Twelve-feet Coal*, the real thickness of which is 12 feet, contained, in the old drift-mines, only about 3½ feet of good coal. The distance of its outcrop from No. 6, the last described, is 183 feet, and the dividing strata are 129 feet thick. Upon the bottom-slate rests about 6 inches of soft coal or "dirt," and upon this the bench of good coal of the dimensions just stated, then an inch or two of slate, and above it the top bench of coal, which is of the kind called *bone coal*, and is not saleable. It is stated that at the end of the gangway, now closed by the falling of the roof, the lower bench of Coal-measures is 8 feet in thickness. The average course of this bed is E. and W., and its dip 48° S.

No. 8=7 *inverted.*—The *Pencil Coal*, distant from the last described 241 feet in a horizontal direction, and in the direction perpendicular to the dip 178 feet, owes its name to the pencil-shaped fragments into which it splits. Its thickness is uncertain, as it has never been regularly entered externally by drifts. In the several shafts sunk upon the outcrop it nowhere exhibited more than 4 feet of coal. The dip of this bed is assumed to be 48° S. Its irregularities and peculiar fracture are due to its being inverted and greatly squeezed by a synclinal fold between it and the Twelve-feet Seam, of which it is the counterpart.

No. 9=6. *Brown's Coal* has a total thickness of 10 feet. It is distant horizontally from the Pencil bed 111 feet, and is divided from it by about 82 feet of rock. This vein was originally opened on the E. side of the ravine. Upon the bottom-slate it there showed about 1 foot of coal-dirt, and above this 5½ feet of soft and somewhat crushed coal unfit for the market; next, 6 inches of slate, then 1 foot of coal, again 6 or 8 inches of slate, and upon the top of this 2 feet of bony coal. In pursuing this vein a short distance, the coal became much crushed, and therefore very inferior. This crushed condition of the coal is accompanied by a want of parallelism of the top and bottom slates. The average dip of the bed seems to be about 50° S., but it is very irregular, the strata in this vicinity being all inverted, and forming the S. side of an oblique or folded synclinal trough.

The *Proved Coal*, not enumerated among the coals cut in the tunnel, perhaps from being too thin to mine, outcrops 127 feet to the S. of the last, with 109 feet of interposed strata. It is probably not thick. It is not exposed in the cutting at the railroad, but, unless some error occurred in tracing it, the outcrop was opened on both sides of the ravine; and according to the superintendent, it there displayed about 15 feet of coal; but as the bed could only be regularly mined by entering it by a cut of considerable length through hard sandstone, it was not further developed. The dip of this bed appeared to be a little N. of the perpendicular—that is to say, less overtilted than the last described.

No. 10=5. The *Vertical Coal*, so called, has in reality a dip of about 60° N. Its distance from the Proved Coal is 87 feet, and the space of rock between them 80 feet. Although, like all the beds in this portion of the section, somewhat variable in its dimensions, its average thickness is about 15½ feet. The estimated thickness of its good coal in the tunnel is 8 feet. Upon the bottom-slate lie about 2 feet of coal-dirt and of soft crumbly coal, succeeded by 8 feet and 2 inches of good coal, containing two thin seams of slate. This 8-feet bench of coal alone is fit for

market, for the remaining upper 5 feet of matter is composed of alternating layers of slate, bony coal, and soft crumbly coal. In some spots the bed was 26 feet thick, but the coal in these slipped places was unfit for general use. This description relates to the E. side of the tunnel; on the W. side it is in too crushed a state to repay the cost of mining.

No. 13=3. The *Fifty-feet Coal*, so termed, rises to the day in a saddle or anticlinal axis, and is well exposed on the E. side of the ravine. (See Plate for a picture of this curious arch of coal.) The horizontal distance of the axis, or more properly of the top of the North-dipping leg, is 236 feet S. of the Vertical Coal, and the distance perpendicular to the dip is 205 feet. On the N. side of the axis the average dip is 60°, on the S. side it is 45°, but the N. leg changes its rate of dip from 60° to 45° as it ranges Eastward in the mine. Both legs of the arch have been mined on the E. side of the railroad, but only the N. one successfully. The bed is penetrated from the ravine by three drifts at the water-level, where the rapid slope of the gorge has made an inclined plane necessary upon the railroad. One of these drifts is on the N. leg, one on the axis, and one on the S. leg. The axis, as might be naturally anticipated, rises Eastward, or towards the compressed and shallow end of the coal-basin. Therefore, in pursuing the coal in that direction, the levels or drifts gradually recede, the span of the arch widening, of course, as it rises above its previous level. To get access to the S. leg from the gangway, which is upon the N. one, two tunnels have been driven across from the one to the other. These tunnels are about 250 yards asunder; that nearest the mouth of the mine lies altogether in the coal, though its length is between 60 and 70 feet.

This is because it cuts across the flattened top of the anticlinal or arch, where the whole breadth of coal in it has risen to the level of the drift. The other more Eastern tunnel, lying upon very nearly the same level, intersects 167 feet of sandstone between the two legs of the arch, showing conclusively that its axis ascends in that direction. This is confirmed by the fact that, on the W. side of the ravine of Rhume Run, the axis or summit of the bed is much lower than on the E. so that it soon gets out of reach in that direction by passing below the water-level. Here the anticlinal axis is double, the slight depression in its centre, seen on the E. side, being here much deeper, passing into a steep synclinal roll, with much confusion and crushing of the inclined coal and roof. This very interesting bed, the identity of which with the Main Lower Coal, already described, cannot be doubted, has about the average dimensions of that seam, although the two legs of the anticlinal arch differ considerably in their thicknesses. The N. leg measures about 22 feet, and the S. one as much as 29 or 30 feet. The probable cause of this inequality is that the South-dipping part of the bed has slipped or yielded in the plane of the stratum, and the coal has thereby become crushed and broken so as to loosen the whole mass, and leave it in a more bulky state.

This coal in the tunnel and S. leg is crushed, but that in the N. leg is very good. In the N. leg the bed consists of 9 feet of good coal, overlaid by 5½ feet of inferior dirty coal, and this by 4 feet of good coal again, the rest of the mass being slaty. This is equivalent to 13 feet of good coal.

In the tunnel the order of things is this: The coal rests upon a stratum of sandstone, and consists of 6 inches of crushed coal, then 3½ feet of rather bony coal, next 2 feet of slate, upon this 1½ feet of inferior coal, and above this nearly 8 feet of good coal, with a little slate. Com-

SADDLE COAL VEIN NESQUEHONING MINES

paring the quantity of pure coal here given with that in the Main Lower Coal, we perceive that the aggregate is nearly the same. The introduction or disappearance of a little slaty matter may cause all the want of agreement witnessed between the two outcrops in the order of the benches of pure coal and slate.

Figure 141 is a diagram of the bed where the shorter tunnel intersects it.

No. 16 *of Tunnel.*—The *Second Southern Coal,* or first thick one S. of the axis, is distant from it horizontally 562 feet, and separated from this great anticlinal bed by about 322 feet of strata. Its thickness is about 15 feet, agreeing with that of the Vertical Coal, of which it is probably the South-dipping portion, the discrepancy in the distances from the axis arising perhaps from the squeezed condition of all the rocks on the N. side of the anticlinal. This bed yields about 10 feet of good coal in two benches, the lower one 6 feet thick, and the upper one 4 feet. The roof-slate is insecure. The dip of the bed is from 25° to 30° S. In Tunnel No. 2 it is evidently squeezed.

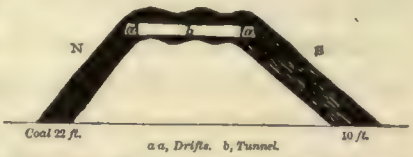


FIG. 141.—Saddle of the Big Coal of Rhume Run at the Short Tunnel.

No. 17 *of Tunnel.*—The *Third Southern Coal* has its outcrop 147 feet S. of the last named, and is divided from it by about 73 feet of underlying strata. At its outcrop it appeared to be about 10 feet thick, but no good coal was procured from the short drifts by which it was penetrated. In Tunnel No. 1, however, its average thickness is 13 feet, but the quantity of marketable coal in it is doubtful. There can hardly be a doubt that this and Brown's Coal are the opposite anticlinal portions of one bed. Its distance across the dip from the First Southern Coal coincides very nearly with that of the Proved Coal above the Vertical Coal, and it is possible that it may be the other leg of that seam. Its dip is from 22° to 30° S.

No. 18 *of Tunnel—Fourth Southern Coal.*—Another coal occurs, S. of that last described, in the tunnel, where it has not yet been mined, but seems to measure in horizontal thickness 14 feet.

No. 19 *of Tunnel—Fifth Southern Coal.*—In 1853 the tunnel terminated in a coal-seam 11 feet thick.

In the foregoing description of the coal-beds, it has been shown that the anticlinal axis seen in the saddle of the so-called Fifty-feet Coal rises going Eastward. When we pursue this anticlinal in the opposite direction, we therefore observe that it no longer lifts to the surface the same great lower bed (No. 3) ; and about three-fourths of a mile from the mines the next higher coals (the "Vertical") and the First Southern beds unite over the axis, both of the legs of which here dip at angles of about 30°. There are indications also that the next superior beds saddle the axis a little further to the Westward. The flattening-down of the dips on each side of this axis shows that it is already contracting and sinking. We shall see hereafter that its influence in the Panther Creek Valley, where it expires, is comparatively unimportant on the larger coals above the water-level. We know that it does not reach the Little Schuylkill, but dies out W. of Coaldale. It is, in fact, one of those many folds in the strata so common towards the terminations of the large synclinal troughs or basins which present a steep dip, or, in other words, a close compression of the rocks in the narrower end of the trough.

From the Nesquehoning Mines there were sent to market in 1856 about 64,291 tons of coal.

BASINS OF PANTHER CREEK VALLEY OPPOSITE SUMMIT HILL, OR BASINS *A*, *A a*, AND *B*.
(See Section through Summit Hill.)

After what has been already detailed of the position and ranges of the two anticlinals A and a, which undulate the strata in the upper valley of Panther Creek, the limits of the three several subordinate troughs *A*, *A a*, and *B*, contained within the wide general basin N. of the Summit Hill axis, will be readily understood.

Locust Mountain Basin A.—This synclinal, composed of the South-dipping strata of the flank of the Locust Mountain, and the North-dipping ones of the axis A, which passes near the mouths of the Tunnels Nos. 6, 7, and 8, is, as the Map and Sections will indicate, very narrow on its S. side, and wide on its N., from the great difference in the inclinations and heights of the outcrops of the strata.

From the Hell-Kitchen Gap at Nesquehoning, eastward, this basin is, as already seen, the sole synclinal of the Coal-field, for by the disappearance of the anticlinal bounding it on the S. in the flank and crest of Sharp Mountain, it comes to be bounded on the one side by that barrier of the whole Coal-basin, while on the other it retains as its limit the barrier of the Locust Mountain. The belt carries its trough-like structure to the vanishing of its synclinal W. of Coaldale. The synclinal axis coincides nearly with the abrupt turn which Hell-Kitchen Creek makes Northwards toward its notch in Locust Mountain. It is seen again in the long Nesquehoning Tunnel, and it coincides very nearly with the bed of the Middle Western Brook of Rhume Run or Nesquehoning Creek. Passing over the table-land of the watershed into Panther Creek Valley, it ranges alongthe depression in which flows the North Branch of Panther Creek, and crosses very nearly at the mouth of Tunnel No. 6. We meet it next within Tunnel No. 7, a few hundred feet from its mouth, and again inside of Tunnel No. 8, about twice as far back from its entrance.

Within half a mile or more further W., the basin, as such, ceases by the cessation of the bounding anticlinal, its N. dip flattening down, and turning into the prevailing S. dips of the slope and foot of Locust Mountain.

Externally, that part of this basin which ranges from Tunnel No. 6 to Tunnel No. 8 is indicated by the middle of the flat terrace, or the plateau N. of the inner valley of Panther Creek; the brow or edge of this plateau being, as previously mentioned, the anticlinal summit of the wave a, of which this is the trough.

As in the instance of the corresponding wide synclinal belt *B* of the opposite or S. side of the Panther Creek Valley, there belongs to this trough a high mountain-breast of coal, and a low one ascending only to the summit of its neighbouring anticlinal; but in both instances these taller sheets of coal, so readily accessible from below by tunnels, offer very superb fields of the thick seam for mining.

Basin A a (*Basin of the Bed of Panther Creek*).—The central synclinal trough is occupied for the chief part of its length from the watershed of Nesquehoning and Panther Creek, westward, by the immediate valley of the latter stream. It is the narrowest of the three subordinate ones, being not much more than 1000 or 1200 feet in breadth. It evidently embraces the highest coals within the Coal-field—those, namely, of the lower Red-Ash group. The dips on the S. side of this trough are very steep, from the acute anticlinal flexure a south of it. Those of its N. side are more moderate, or about 45°, as the Section will make apparent.

Basin B.—The Southern one, B, is well defined by its topography, being bounded on the S. by the N. flank of the Summit Hill and the Sharp Mountain, where these become one, and on the N. by axis A, the S. of the two saddles, or that S. of Panther Creek. The central line of this trough is, for the chief part of its length, either a well-marked depression in the plateau S. of Panther Creek, or a flat portion of it, from Plane 2 eastward to beyond the old letting-down plane.

It is into this basin, the widest of the three subordinate ones, that the new Tunnel, No. 9, is now being driven, with a view to tap the great Coal-bed of the Summit Hill, descending into it with a N. dip.

Almost precisely at the synclinal axis, the roof of this tunnel fell in where the soil was more than 50 feet above it. Though the summit of the narrow anticlinal ridge intersected by the tunnel has an elevation of 80 or 90 feet above Panther Creek, and exposes the solid strata, the material from the roof of the tunnel to the surface in the synclinal proved to be wholly soft clay and included fragmentary drift. From this axis of the basin to the assumed point of intersection of the large Coal-bed, at the tunnel level, the distance is estimated to be some 1500 feet, the place of the synclinal axis being 600 feet S. of the tunnel's mouth. The Coal-beds cut in this tunnel at the synclinal axis are the small Red-Ash seams of the immediate basin of Panther Creek, or those which pass S. of the mouth of Tunnel No. 8 ; but what their precise equivalents may be, we have no means of determining. The dips on both sides of this basin are very steep.

Basin B C, or Basin of the Lehigh Summit Mines.—This basin, enclosed between the Sharp Mountain and the axis B, or anticlinal of the Summit Mines, presents the extreme E. point of its Coal-measures at the Breaker east of the East Summit Mine, or nearly opposite the notch in the Sharp Mountain. Its conglomerate-border ends in Mount Jefferson. It gradually widens and deepens W. Its central line ranges along the hollow between the Sharp Mountain and the Slope Mine No. 2, beyond which point we cannot trace it with precision, though it undoubtedly extends to the Little Schuylkill at Tamaqua. Viewing the most N. of the Tamaqua anticlinals as that of Summit Hill prolonged, it is apparent that on the Little Schuylkill there are three saddles embraced within the general synclinal belt or coal-field. The most S. of these, the Mine Hill axis, may extend E. in this basin to the Sharp Mountain, but the obscure condition of the surface S. of Panther Creek does not allow us positively to assert this. There is a hitch in the crest of the Sharp Mountain about one mile E. of the Summit Village, which I am strongly inclined to regard as the running-out of the Mine Hill anticlinal. If so, the true Summit Hill trough will be that of the immediate valley of Panther Creek, opposite the Greenwood Breaker, and thence W.; and the S. synclinal of Tamaqua, at the N. foot of Sharp Mountain, will be an independent basin to the S. of this one.

As it is impossible, in the present imperfectly-developed state of the coal-field, to pronounce positively which of the two anticlinals N. of the town of Tamaqua is the main Summit Hill axis, it is equally impossible to determine to which of the main basins, whether that of the Coaldale Valley or that of Summit Hill, the narrow enclosed trough contained between these two axes belongs, or rather into which of them it ranges.

Summit Mines of the Lehigh Company, Basin B C.—Advancing W and S. along the coal-field, the next locality at which the strata are sufficiently uncovered to render a detailed description of them instructive, is that of the great open quarry of coal called the Summit Mine of the Lehigh Company. The general continuity and range of the coal strata from the extreme E. end of the basin near Mauch Chunk to this spot has been satisfactorily proved by the discovery at

many intermediate places of ample masses of coal, but the extremely accessible position of the coal at Nesquehoning, Panther Creek, and the Summit Mines, has hitherto prevented the Lehigh Company from opening up any other portions of their vast coal estate.

The Summit Mines are situated about 8½ miles W. of the Lehigh River at Mauch Chunk, about 4½ miles from the Nesquehoning Mines, and not quite 6 miles E. from the Little Schuylkill at Tamaqua. Their position is on the S. margin of the coal-field, on an elevated table-land or shoulder of the Sharp Mountain, the adjacent narrow crest of which, as marked by the rugged outcrop of the conglomerate, rises but one or two hundred feet above the general level of the old open mine or quarry. From the margin of the open mine to the level of the Lehigh at Mauch Chunk the descent is 936 feet. Notwithstanding this difference of level, a railroad has long been in successful operation, conveying the coal from the mines to the Lehigh navigation, the motive power being the gravity of the loaded cars. Formerly the reascent to the mines was accomplished by mules, who descended in their own trains to Mauch Chunk to be ready to pull back the empty cars. This well-constructed road is interesting in the history of the internal improvements of the United States, as being the second railroad of any description built in the country, the first being the short road from the granite quarries of Quincy to the water-side.

There is a table-land or wide elevated flat at the mines, about half a mile broad, measured from the base of the crest of the Sharp Mountain. From its N. brow the ground descends in a long and steep mountain-slope to Panther Creek, which occupies the position of the general synclinal axis of the basin. This flat, united to the Sharp Mountain on the S. and E., as indicated upon the Geological Map, is separated from the Sharp Mountain on the W. by a dell or depression, drained by a little tributary of Panther Creek, called Coal Mine Run. This jutting forward of the shoulder of the mountain towards the W. arises simply from the presence of the anticlinal axis B, which, starting from the Sharp Mountain, or rather from its S. flank, recedes from the mountain as it extends W., and holds up the Coal-measures over the breadth of the flat. The W. spur-like termination of the flat is caused by the W. declension of the anticlinal axis. Whether this anticlinal extends to the Little Schuylkill is, as we have already said, somewhat uncertain.

The position of the coal and general structure of the basin at the Summit Mine is shown in the general transverse section of the coal-field (see Plate VI.), upon inspecting which, it will appear that the strata forming the flat undulate in one broad wave, with several lesser sharp folds in the S. side of the basin, due to compression from the steep uplifting of the conglomerate of the Sharp Mountain. The N. flank of the wave pitches steeply into the valley of Panther Creek, while the strata rise at the base, and upon the S. slope of the Locust Mountain. Upon the summit flat these undulations expose only the two lowest coal-beds, all the rest having been swept away by denuding waters. Of these lower beds, the second alone is important, but its dimensions and value are unsurpassed; it is that which is so extensively laid open to the day in the Great Summit Mine. The other bed, only 3 feet thick, has been proved, it is alleged, between the mine and the conglomerate of the Sharp Mountain, and it is therefore lower in the series than the large mass of the open mine, and is probably at the very base of the Coal-measures.

Our sketch (see Plate) conveys a good general conception of the position and extraordinary dimensions of the main bed of the Summit Hill. The picture embraces in its foreground the N. portion of the great open coal quarry, the beholder looking towards the W. On the left is the narrow crest of the Sharp Mountain, in the middle distance lies the centre of the coal-basin occupied by Panther Creek, in the background range the valley W. of the Little Schuylkill and

LEHIGH SUMMIT MINES, EAST MINE

Locust Mountain, the N. boundary of the coal-field. The great coal-bed, in its total thickness, measures about 55 feet, and a large portion of it, certainly more than 30 feet, is coal of superior quality. The mass is composed of separate beds of pure coal of various thicknesses, separated by included layers of more earthy coal and bands of slate. Its constituent seams of pure coal and of slate show a great general persistency throughout the mine; and this fact, in connection with others to be presently mentioned, lends a high degree of probability to the opinion already expressed, that the unusual thickness of the bed is the result of a union of several of the large beds of the lower part of the series, by the mere thinning-away of their dividing strata.

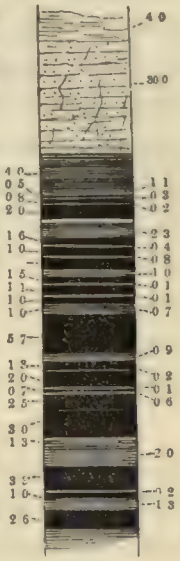


Fig. 142.—Subdivision of the great coal-bed of Summit Mines.

This open part of the great mine discloses the saddle or summit of the broad anticlinal axis B. Upon the very summit of the arch the coal itself comes to the soil in some places, and it was here, towards the E. point of the basin, that the excavation first began. In these naked spots the Anthracite was in the state of a fine black powder or sand to a depth of even 2 or 3 feet, and under it, for several feet, the coal was loose and fragmentary. As the work extended N. and S. from the crown of the arch, the overlying sandstone grew progressively thicker, until it amounted upon the N. slope to a covering of more than 30 or 40 feet, up to which thickness it was removed and the coal quarried under the open day. This process has now ceased, as the mining is all subterranean, by slopes and tunnels.

The floor upon which this enormous bed of coal rests, is the compact sandy fire-clay or shale so usually met with in this position. The cover, as in very many instances in the anthracite Coal-measures, is a somewhat firm, yellowish, and green sandstone, and not the laminated black slate, which in other fields forms the more usual roof stratum of the coal-seams. Here the sandstone lies in intimate contact with the coal, not the thinnest seam of slate or argillaceous matter being interposed, and the granules of sand at the lower surface of the rock have even numerous specks of the anthracite mingled among them.

This great excavation of coal, only one portion of which is included in the picture, as it showed itself in 1841, then occupied an open area of probably 45 acres, but the uncovering continued until the quarry engrossed more than 50 acres. The waste coal and rubbish were conveyed Northward out of the quarry by short railroads to the brow of the hill, overlooking the Panther Creek Valley, and there piled until some truly enormous hills of it were accumulated. But it was found necessary at last to deposit the rejected matter within the area from whence the coal had been quarried out, which caused this to lose its once very striking and picturesque features. Many portions of its almost perpendicular walls are still standing, however, showing black cliffs of solid coal for a height of more than 50 feet, overtopped by a wall of yellow sandstone of a nearly equal additional height.

To the E. of the principal quarry, and rather nearer to the crest of the Sharp Mountain, lies the smaller mine, where also several acres of the great coal-bed were uncovered. This is situated upon the Southern margin of the basin, near its Eastern end, at what is apparently a subordinate anticlinal, the arch of which is however more crushed than that of the gently-curved axis of the Summit Mine. Between these two anticlinals the coal is nowhere very deep below the surface. Our sketch of the East Mine, so called, shows it at a time when it was not wrought, and was half

filled with water; the other sketch displays its condition in 1853, after the mining had been resumed. As the coal gradually dips Westward, away from the level of the plateau, with the declension of the anticlinal arch and the surface of the ground in that direction, and as it laps regularly round the end of the broad spur in which the table-land terminates, sinking in level towards the bed of the valley both N. and W., there will be, as the mining advances, a continually-increasing lift to overcome, before regaining the summit of the present railroad at Summit Hill, E. of the mines. So also as the mining advances Westward, down Panther Creek Valley, it will be necessary, ultimately, either to send all the coal to market by its more natural outlet, through the valley of the Little Schuylkill, or to surmount the ascent to the present summit by locomotive power in addition to the present stationary power and inclined planes, or else by both means convey it to the Lehigh, by the gorge of the Nesquehoning, and thence over the present railroad from the Rhume Run mines.

An unexaggerated estimate of the average working thickness of the coal in the coal-field, between Nesquehoning and the Little Schuylkill, deduced from the actual experience of the mines, makes the total to be about 40 feet. At this rate every available acre contains not less than 65,000 tons of coal.

It will be seen, as we proceed in the detailed description of the Coal-measures of the several districts of the basin, that there everywhere prevails, low in the series, or within a few hundred feet of the main bed of conglomerate, one or more very large beds of White-Ash coal; and a comparison of the data connected with these remarkable outcrops shows that, though they do not all appertain to one continuous stratum, they are all approximately on two or three contiguous horizons, sometimes one, sometimes another, expanding to unusual size, often by admission of adjoining smaller beds.

The only question open to discussion is, whether, in an instance like that of the huge mass of the Summit Hill mines and Panther Creek tunnels, where the bed possesses very unusual thickness, the expansion of its size is caused by the merging into the principal bed of other adjoining coal-seams through the thinning-away of the dividing strata, or is merely a local enlargement of the one coal-bed between the same roof and floor, arising from more active deposition at this spot of the vegetable materials which formed it. If we were in possession of any complete sections of the lower Coal-measures, such as those of the Nesquehoning and Tamaqua coals, illustrative of the condition of things nearer to the Summit Mine than these localities, we might, from such data, possibly determine the running together or not of some of those beds to form this great deposit; but no intermediate points have been developed, and the distance of the two localities named, one 4½ miles and the other 5 miles, is too considerable to permit us to institute any close comparison between the individual beds at either of them, and that of the Summit. To explain the unusual thickness of the great bed by the coalescing of several large seams of the Nesquehoning group, we must assume, if we take the "main lower coal" and the two next which overlie it, as those which have here come together, that there has occurred a total exhaustion of about 134 feet of included rock; or, if we suppose only this "main lower coal," and the double or "Rowland's coal," to have united, we have still to conceive of the thinning-out of at least 77 feet of sandstone, in a range of only 4½ miles. A like difficulty besets us when we consider the thick plates of sandstone and slate which we must assume as having disappeared between the Little Schuylkill and the Summit, if we would derive the great bed from the coming together of any two or more of

EAST WORKINGS IN OLD LEHIGH SUMMIT MINE

Shewing Subordinate Anticlinal Axis

the principal lower seams of that locality. Nevertheless, so much more uniform are the coal-beds generally than the mechanically-derived sandstones,—so much more easy is it, when we advert to the respective circumstances under which these two classes of deposition originated, to ascribe a rapid variation of thickness to the wildly-strewn strata of sand and pebbles than to the slowly and gently accumulated layers of vegetation of the ancient carboniferous marshes—that I strongly incline to that view which assumes the apparent alteration of thickness to be due to the thinning-out of the arenaceous rocks.

The total product of the Summit Mines of the Lehigh Company, for 1856, is stated to have been 284,711 tons, and for the past year (1857), 306,396 tons.

Coals of Panther Creek Basin and Saddles.—It has been already mentioned, that the Coal-measures of the Panther Creek Valley include, in the vicinity of Tunnel No. 8, coals as high in the series as the first or lowest five or six beds of the Red-Ash group. It is obvious that these basin out in succession along each trough in advancing Eastward, the uppermost first. And it is equally plain, from the structure of the district,—the disposition in echelon of the several basins, each more Southern trough and saddle originating further W. in Sharp Mountain,—that the same coals terminate always sooner going Eastward in the more Southern belts than they do in the more Northern. Where the lowest Red-Ash coal finds its E. limit in the first of these basins, *B*, at the foot of Summit Hill, is not precisely known; but we may fairly infer it to be far E. in the hollow of the S. branch of Panther Creek, or even on the table-land beyond it. We know that the Nesquehoning coal, No. 3, or the 28-feet bed, is elevated to above the high-water level of the Nesquehoning Creek, in the 2d or N. anticlinal, A, and that even there the height of the table-land W. of this arch of the coal is sufficient to give a cover to the first of the Red-Ash coals. On this anticlinal A, therefore, the Red-Ash coals extend thus far at the least to the E. But on the other shorter and more subordinate axis, next S. of it, the probability is small that they range so far, or that they pass beyond the hollow which encloses the source of the S. branch of the Nesquehoning. It is indeed just in range with this axis that we have on the edge of the plateau, at the foot of Sharp Mountain, in the line of the tunnel, the outcrop of the large Nesquehoning White-Ash coal, the smaller anticlinal having probably ceased somewhere to the W. of this. Along both the anticlinals of Panther Creek Valley, in its enclosed synclinal trough of the immediate valley of the stream, we may trace, by fair inferential evidence, the presence of the Red-Ash coals, which are thus undulated in this central tract of the general basin, in four alternate N. and S. dips.

In the most Northern of the subordinate troughs, Basin *A*, or that intersected by the tunnels No. 7 and 8, the higher of the embraced Red-Ash coals must throw themselves out Eastward—the highest of them in the valley of the N. branch of Panther Creek; while the lower rises more forward, no doubt, across the plateau to the Nesquehoning and the Hell-Kitchen creeks, and preserve their stations within the central belt of the basin, even much further E., perhaps to within a mile of the meridian of the Old Mauch Chunk Tunnel, near to which the Great Summit bed, or rather the large Nesquehoning division or branch of it, is lifted at last nearly to the day in the centre of the basin, by the joint agency of a local saddle and the excavation of the surface.

Westward from Coaldale it is not needful to trace the course of the several coal-beds in detail. Those recognised on the Little Schuylkill, and at Greenwood Tunnel, are indicated on the Map, as far as identified by the working of the mines, or traceable by the natural benches and

other features which mark the lines of outcrop. To the Map and Sections I must again refer the reader. It is fit, however, to define in this place the ascertained range of the guiding coal F, of the Tamaqua series, as this has been already quite extensively and connectedly mined, both E. and W. of the Little Schuylkill, and the more especially as it occupies that very important horizon in the Coal-measures which separates the White-Ash from the Red-Ash group of coals. It is fortunately both a very persistent coal-bed and an exceeding pure one, and is moreover of the valuable thickness of from 10 feet to 12 or 14 feet—circumstances which have led to its being more extensively developed by mining than any other seam in this portion of the basin, if we except perhaps the still thicker subjacent bed E.

This valuable coal is wrought at Tamaqua on both sides of the river, on the N. side of the basin, and is the vein called O of the S. side. It is likewise intersected in the Greenwood Tunnel, 1 mile E. of Tamaqua, and its identity fully established by tracing and by its relative position. From the Greenwood Tunnel eastward it has been mined above the water-level of the tunnel, a distance of at least 1½ miles, and is well defined at its outcrop by the bench or terrace which follows it, and by the series of air-holes driven through it to the surface. At Carter's New Slope, about 3000 feet E. of Greenwood Tunnel, this coal is opened below the level of the Greenwood Tunnel gangway, a slope depth of 300 feet or 500 feet from its outcrop. The furthest point to which it has been mined on the upper level is a mile nearly E. of this new slope, bringing it to within less than 2 miles of tunnel No. 8 of Panther Creek Valley. The position of its most Eastern air-shaft, at the date of observation, November 1853, is given on the Map. The day cannot be at all remote when the extension of the gangways Westward from tunnel No. 8 will enable us to identify this coal with one of those in the tunnel. That it will prove to be the main Red-Ash bed of that and the neighbouring tunnels there can even now be but little doubt.

The dips in this coal at its outcrop, as far as traced Eastward from the Little Schuylkill, are worthy of record, as displaying the more than usual regularity of structure which belongs to the N. side of the basin of Panther Creek. At Tamaqua the S. dip is 55°, in the Greenwood Tunnel it is 60°, and at Carter's New Slope it is again 55°.

This coal F will, in a future page, be identified at various successive points Westward from Tamaqua, as far at least as Palmer's Tunnel, W. of Tuscarora.

Basin D, or Basin of Sharp Mountain and Anticlinal Axis C.—It has been already stated, that an anticlinal axis passes through or originates in the Sharp Mountain E. of the head of Dry Hollow, and that, keeping S. of the Valley of Panther Creek, it extends towards the town of Tamaqua, and it was intimated that this, if not identical, is nearly coincident with the Mine Hill flexure which passes the Little Schuylkill on the S. edge of that town. Between this saddle and the crest of Sharp Mountain there is a slender basin in the Coal-measures, containing no coal S. of Dry Hollow, but expanding and deepening Westward to the Little Schuylkill, where it contains a full suite of coals, including all the White-Ash and several of the lower Red-Ash beds of the district. Except at the Little Schuylkill, the coal-seams of this sub-basin have not been opened, either experimentally or by systematic mining, and we shall therefore have no details to submit concerning them until we describe the Coal-measures as they are developed on the Little Schuylkill. Upon general considerations, it is obvious that the narrow Eastern half of the part of this belt, E. of Tamaqua, can contain none of the Grey or Red Ash coals, which can only enter the basin as we approach the Little Schuylkill. It must be somewhere within the Eastern half

of this trough, probably opposite the Western half of the Dry Hollow Ridge, that the Big coal of the Summit Mines subdivides, to form a part of the White-Ash group, as seen at the Little Schuylkill. Judging from the condition of the Coal-measures on the Little Schuylkill between Tamaqua and the Sharp Mountain, this basin does not promise a large product of sound coal, notwithstanding the great dimensions at the surface, of its lower seams. The Sharp Mountain all along this portion of its course has its strata almost on end, and it is sufficiently apparent, that not only the coals between its conglomerates, but those at its N. base, are greatly squeezed. It is probable, indeed, that those near the synclinal axis, or turn of the basin, are even overtilted. What may be the condition of the Red-Ash coals, adjacent to the saddle C, which bounds the basin on the N., we have no means of positively judging; but we are entitled to infer, that all the Red-Ash measures adjoining, and included between all three of the anticlinal axes of the centre of the coal-field at and E. of Tamaqua, and probably W. of it for some distance, are in too disturbed and crushed a condition to admit of being profitably mined, at least at the present day. It does not follow, however, that the subjacent or White-Ash thicker beds, enclosed between less flexible strata, are as sharply undulated, or as much crushed by sliding pressure.

THE COAL-MEASURES, UNDER THE SEVERAL LOCAL TYPES THEY PRESENT BETWEEN THE LEHIGH AND LITTLE SCHUYLKILL.

The Coal-measures, using this term to signify all the strata above the conglomerate, or that portion of the coal-formation which is productive in coal-seams of notable dimensions, display some unusual and very interesting features and fluctuations of type, as we follow them for the short space of 13½ miles, from their E. termination near Mount Pisgah to the Little Schuylkill at Tamaqua. Comparing the sections supplied by the Old Mauch Chunk Tunnel and the Nesquehoning Tunnels at the E. end, with those of the Summit Mines and Panther Creek tunnels, in the middle part, and with the Tamaqua Mines at the W. limit of the district,* we are forcibly struck with the very great disparity between them.

In the Mauch Chunk Tunnel, or most E. section, there would seem to be about ten or twelve separate beds of coal, of all dimensions, from 1 or 2 feet of thickness to 17 or 18 feet. And all of these, as far as we can ascertain, are White-Ash coals. So likewise in the Nesquehoning section (see Tunnel No. 1.), we find seven, or possibly eight, well-recognised coals, five of which are of thicknesses between 12 and 17 feet, while the two smallest are 3 and 4 feet respectively, and none of these are Red-Ash coals.

About 360 feet W. of Tunnel No. 8, the coal, usually 55 feet thick, grows thicker; and at 600 feet, from the end of the gangway in 1852, it was from 90 to 100 feet thick; but this is manifestly in consequence of a doubling or slipping of the seam upon itself.

At the Panther Creek Tunnels and the Summit Mines the coal is very differently distributed. The five or six upper beds of Nesquehoning are here, by all indications, united into one great stratum, which varies from 45 to 55 feet in its aggregate thickness. Thus far researches in the vicinity of the Lehigh Summit, and the parts of the Panther Creek Basin opposite to it, have shown that the whole of the White-Ash series is represented by this one great bed alone, with an insignificant coal-seam at a short distance beneath it. In the ascending order, the

* See the several sections and vertical columns of the Coal-measures at these localities.

coals which next succeed the large bed are two thin *Grey-Ash* seams, and upon these repose five or six Red-Ash beds, the lowest of which, containing 10 or 11 feet of coal, is extensively mined in some of the Panther Creek Tunnels as a genuine Red-Ash coal.

Here, then, occurs a very extraordinary thinning-away between Nesquehoning and Panther Creeks, of all the rocks of the former locality, interstratified among the coals of the chief part of the thick White-Ash series. Not less than 350 feet of thickness of strata: coarse grits, argillaceous sandstones, and sandy shales and slates, have thinned down and disappeared within a space scarcely exceeding 3 miles. These rocks, if represented at all at the Panther Creek Tunnels and Summit Mine, are only to be traced in the thin partings or seams of slate and fire-clay, of which one only exceeds 2 feet in thickness, which separate the constituent layers of coal of the large mass. I think it every way probable, that the Nesquehoning coals, which thus unite to form the large bed, are the so-called Twenty-eight-feet, the Five-feet, the Nineteen-feet, the Thirty-nine-feet, and the Twelve-feet seams.

Turning now to the Tamaqua section, we behold a subdivision of at least the White-Ash portion of the Coal-measures, altogether dissimilar from either that of the Lehigh Summit Mines or that of Nesquehoning. Here the White-Ash or lower group, everywhere the most variable division of the Coal-measures, is now subdivided into no less than eight or nine important beds of coal, separated by thick strata of alternating sandstones, conglomerates, and shales—the individual spaces between the coals, filled by these rocks, being from 50 to 200 feet in thickness. Assuming the lowest of the Grey or Reddish Ash coals to be persistent throughout the district, as the facts seem to warrant, we are forced to regard the four or five upper thick White-Ash beds as only the prolongations of the subdivisions of the great bed of the Summit Mines, wedged further and further apart in their progress Westward by the constantly-expanding strata of the sandstones, shales, and conglomerates. I am disposed to view the Tamaqua coals B, C, D, the D cross-cut, and E, as all five of them united at the Summit Mines in the one great 55-feet-thick deposit. This hypothesis supposes that the bed A is represented at the summit by the solitary thin coal-seam beneath the larger mass, while the two still inferior ones of Tamaqua have thinned away Eastward altogether; and it assumes the main conglomerate mass of the crests of Sharp and Locust Mountains, opposite the Summit Mines, to terminate upwards with the Nut conglomeratewhich, at Tamaqua, underlies the coal A: the other thinner and less coarse pebbly beds, interposed between coals A and B, and between B and C, having, with the other separating rocks, all dwindled away before they reach the Summit Hill and upper valley of Panther Creek.

The data collected do not permit us at the present time to trace the Grey and Red Ash coals further Eastward in the basin than the sources of Panther Creek—the shoaling of the basin seeming to have caused their denudation at the Nesquehoning Mines and everywhere beyond. An inspection of the Tunnel Sections of Panther Creek and of the Tamaqua Section will display the same number, usually two, of Grey-Ash coals, interposed between the White-Ash group and the genuine Red-Ash coals; the first of the latter class being very generally, even indeed for many miles W. of Tamaqua, the third bed above the highest true White-Ash seam. The number of the proper Red-Ash coals evidently increases towards the Little Schuylkill, with the progressive deepening of the coal-field going W. Thus, we count about six such beds, from 1 foot to 7 feet in thickness, in the Westernmost Panther Creek Tunnel, or No. 8, and about nine of similar various dimensions at Tamaqua.

OF THE POSITIONS IN THE GENERAL BASIN OF THE SEVERAL GROUPS AND THE MORE IMPORTANT INDIVIDUAL COAL-BEDS.

It is not in our power, in the present undeveloped condition of this extensive valley, to speak with satisfactory precision, except in a few instances, of this very interesting part of the subject.

Beginning with the coals lifted to the surface on the arch of the Summit Hill anticlinal, the great summit bed, as already shown, converging its outcrops from the basin of the old mine on the one side, and from the flank of Sharp Mountain and N. side of Summit Hill on the other, unites near the head of Slope Mine No. 2, on the anticlinal axis. This axis declining Westward, the Red-Ash vein saddles it at a distance of a few hundred yards, at a point where the spur is rapidly descending opposite the village of Centreville, or about 1 mile W. of Slope No. 2. This declension of the anticlinal Westward, brings the Large Summit Coal at Tunnel No. 2, in the Dry Hollow Ridge, to a lower level than its place at the slope by several hundred feet.

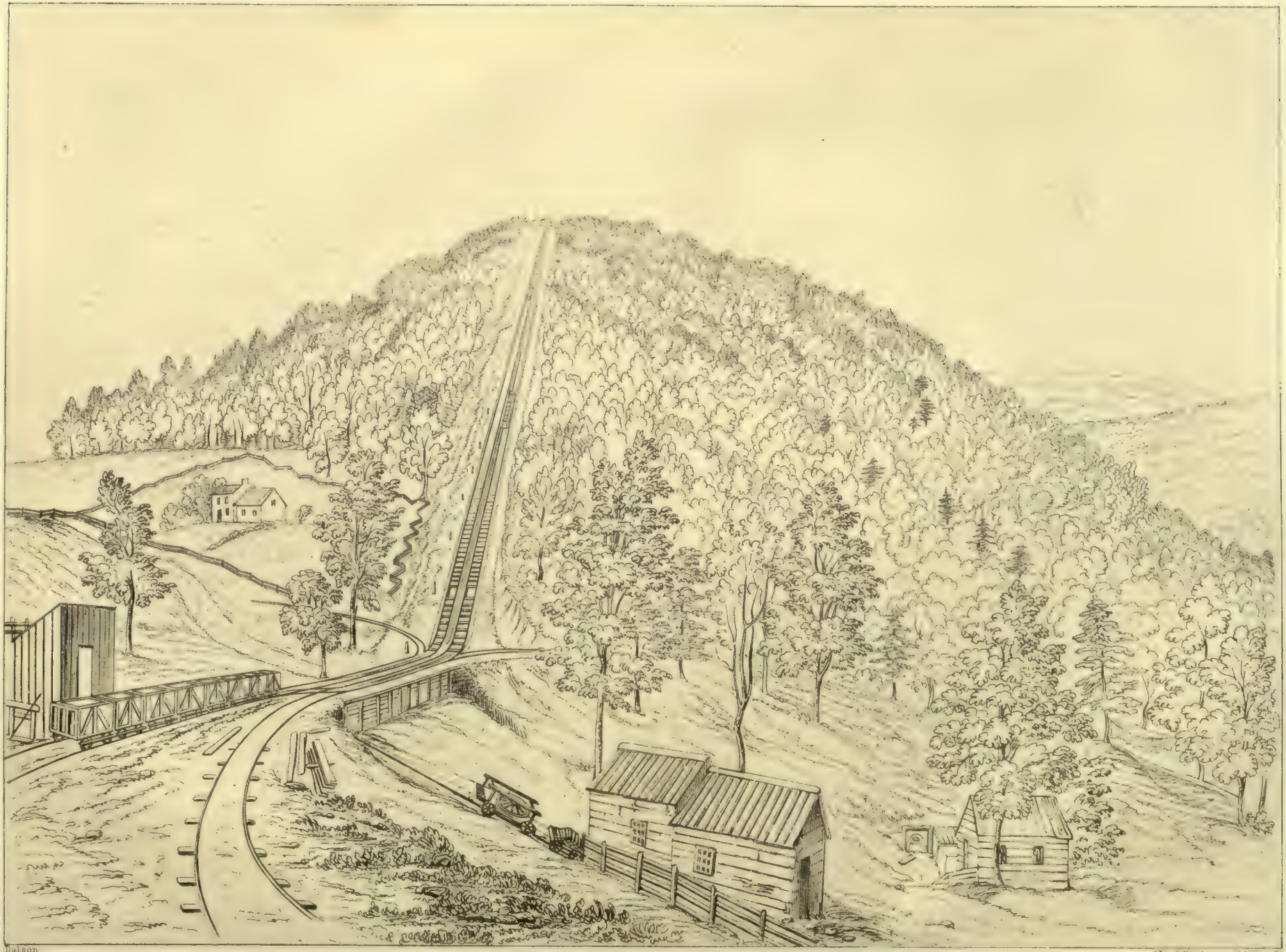
Dry Hollow Ridge, having the axis within it, receives, between this anticlinal bend of the large coal and its crest, a sufficient thickness of Coal-measures—especially W. from the tunnel—to include several of the Red-Ash coals. And thus, notwithstanding the gradual Westward descent of its crest, three Red-Ash beds have been opened on it about three-fourths of a mile from the tunnel in that direction. Underneath them the large coal is no doubt far below the water-level of the valley. From the data embodied in the Tamaqua Section, we are enabled to approximate to the depth of the Great Coal seam at the Little Schuylkill on this anticlinal, or where it approaches nearest the surface, and the inference is, though it should be accepted with some latitude, that the coal comes to within perhaps 800 feet of the soil. The coals, which there saddle this axis above the water-level, are beds which belong to the middle division of the Red-Ash group. By the large bed we here mean, of course, only its upper member, or the coal E. of Tamaqua.

Coals of Summit Hill Basin, B, C.—Of the coal-seams contained within the basin enclosed between the Sharp Mountain and the above-mentioned anticlinal B, it is enough to state that the Great Summit bed has the E. end of its own basin E. of the New Mine at the breaker; and that W. of the Meridian of slope No. 2, the Red-Ash coals appear within it in successive concentric troughs, all deepening towards the Little Schuylkill, until, by the intrusion of the middle Tamaqua anticlinal, the centre of the trough is re-elevated to some unknown extent. The highest coals included in either branch of this basin at Tamaqua are seemingly those about the fifth or sixth in order above the upper White-Ash beds. These are, however, not mined on the Little Schuylkill, partly because they are to be reached only below the water-level of the valley, and partly on account of their less thickness when compared with the White-Ash coals. They are probably also more faulty, from being more involved in the anticlinal and synclinal flexures.

Arrangements of the Lehigh Company for Conveying the Coal of Panther Creek and the Summit Mines to Market.—The Lehigh Company has constructed many remarkable works for the transportation of their coal,—railroads, inclined planes, tunnels, locks, &c., chiefly planned and built by their very able engineer, Mr Douglas. Their system of conveying the coal from the Panther Creek and Summit Mines to the Lehigh Navigation at Mauch Chunk is so ingenious and successful as to merit a concise description here. Locomotive steam-power is entirely dispensed

with, and recourse is had to inclined planes with stationary power, and to the propelling force of gravity upon railway tracks of a requisite gentle slope. Availing themselves of the singularly favourable physical features of the district, the Lehigh Company and their engineer completed, several years ago, a chain of gravity tracks and inclined planes, extending from Mauch Chunk to the Mines and back again to the Navigation in an endless circuit. It consists of two independently-planted, single-track railroads ; one for conveying the loaded trains from the Mines to Mauch Chunk, the other the empty trains back from Mauch Chunk to the Mines. Their routes, though somewhat different, intersect each other. The whole system will be readily understood by consulting the Map, and attending to the following description of the circuit which the coal-cars, loaded and empty, are made daily to perform. Let us begin at the remotest part of the line, say at Tunnels No. 6 or No. 7 in Panther Creek Valley. The coal-cars, after receiving their freights of coal, previously picked and screened near the mines, convey it, by force of gravity alone, upon a gently-inclined railway track, graded with an inclination of not less than 40 feet to the mile, along the immediate valley of Panther Creek to the foot of Plane No. 2. Here they are coupled into sets of three, and hoisted rapidly by ample stationary power to the summit of the plane. This plane has a length of 2030 feet, and a vertical lift of 250 feet. Collected at the summit of No. 2, they are allowed to run by gravity, under proper checks, E. to the foot of Plane No. 1, losing a little of the elevation they had gained. At No. 1, they receive a lift of 375 feet over a plain 2436 feet long. They are now at the summit-level between Panther Creek Valley and Mauch Chunk, their position being just on the anticlinal axis *B*, N.W. of the village of Summit Hill. From this point their course to Mauch Chunk is unobstructed, and they now start upon their journey over what is called the Loaded Track. They are made up into trains, not embracing more than sixteen cars in each train, controlled by a brakeman, who sits aloft, holding a rope to which the brake-handle of each car is attached by a shorter cord, and who is thus enabled effectually to bridle the whole, and they are sent on their journey by a push from the shoulders of two or three men. Starting off with a smooth and gentle motion, they soon acquire a rapid speed, which occasionally requires the brakeman to rein them in. They glide first across the head of the basin of the Summit, then Southward and Eastward round the flank of Mount Jefferson, and, passing under the inclined plane of that name, take the S. flank of Sharp Mountain, along which the loaded track, descending at an average grade of 40 feet per mile, now passes for about 3 miles, until nearly opposite Nesquehoning. There it diverges towards the valley of the Mauch Chunk Creek, which it pursues for 2½ miles further, when the creek, descending too rapidly, the railroad, to maintain its own grade, passes on the brow of a sloping table-land N. of the stream, along which it holds its course to the upper village overlooking the Lehigh, where the loaded trains come to a pause and are discharged. The terminus of the Loaded Track has an elevation of about 200 feet above the pool or slack-water of the Lehigh at Mauch Chunk, and this descent is overcome by the coal by the contrivance of a series of schutes, or inclined troughs, to be described presently. The total descent from the summit at the head of Panther Creek, Plane No. 2, to the surface of the water at Mauch Chunk, where the canal boats receive the coal, is 946 feet. From the summit of the Loaded Track to its lower terminus the length is about 8½ miles.

Having discharged their freights, the now empty coal-cars are conveyed, still by gravity, to the foot of the first lifting-plane of the empty or return-track. This plane ascends along the



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MOUNT PISGAH PLANE, MAUCH CHUNK.

E. spur of Mount Pisgah, an outlying terminating synclinal knob of Sharp Mountain. (See the Sketch of the Mount Pisgah Plane.) The perpendicular lift to the summit of the Back Track at the head of this plane is 825 feet. The cars are pushed up the plane by an ingeniously-contrived pushing-car or truck connected with an endless chain, or rather broad band of tough plate-iron, propelled by a stationary engine at the summit. The safety-car, as it is called, rests at the bottom of the plane below the level of the track, in a deep long trench or pit, and the empty cars, in requisite number, are shoved over it. At a signal given, the endless band is set in motion, and the safety-car drawn out of its pit to the rear of the empty train, which thus begins its journey towards the summit. The speed of the ascending train at Mount Pisgah is usually 370 feet per minute. From the summit of the empty track the empty cars descend at an average grade of 50 feet per mile along the S. flank of the Sharp Mountain, a distance of a little more than 6 miles to the foot of Mount Jefferson. There they are lifted by another inclined plane, No. 2, of the empty track, a height of 462 feet, at a speed of about 740 feet per minute, the plane having a length of 2070 feet. From the head of the Mount Jefferson Plane the empty track is continued to the village of Summit Hill, a distance of nearly one mile, with a grade of nearly 44 feet per mile. The rest of the journey to the mines is made by what is called the Back Track, which, setting off from Summit Hill, runs by two branches or separate routes into the Valley of Panther Creek. One of these diverging N., and crossing the anticlinal axis of the summit W. of the Catholic chapel, turns Eastward, and, descending the mountain obliquely, meets a zigzag or switchback track near Tunnel No. 5, beyond which it enters the immediate valley of Panther Creek, which it follows closely to our points of setting out, the breakers connected with Tunnels No. 6 and No. 7. The other, or Sharp Mountain Back Track, passes through the Old Open Mine to the head of Dry Hollow, which it recrosses by a switchback track, and then resumes its course until it turns Northward and Eastward over the anticlinal spur of the Summit axis, 2000 feet W. of Slope No. 2, till it reaches the head of Plane No. 2. Here the empty cars may either descend the plane, or, keeping the hill, pass Eastward to the foot of Plane No. 1, passing, in the interval, near the mouths of Tunnels No. 3 and No. 4.

A separate lifting-plane is employed to elevate the coal drawn from the bottom of the Summit Mine by Slope No. 2, and sent forward to the Main Loaded Track. This Plane, No. 3, descends North-westward from the foot of the conglomerate crest of Sharp Mountain. Its length is about 2200 feet, and the head of the plane lies not far W. of the S. quarry of the Old Open Mine.

The fall of the Back Track is about 300 feet.

Coal Schutes at Mauch Chunk.—At Mauch Chunk there are four schutes or inclined troughs for letting down the coal from the end of the railroad to the river. They are respectively 750, 700, 650, and 600 feet long, and their inclination is 1 in 3, or 17°. Their lift from the river is 213 feet to the Loaded Track. The fourth schute is a slide schute—a trough 5 feet wide and 4 feet deep, with gates 50 feet apart. The trough is ironed on the bottom with half-inch cast-iron plates 1 foot by 4 feet. There are eight gates. The coal is not materially injured by the friction, and what loss occurs is compensated for by the facility and saving in labour. There is also a large wooden schute from the plateau at the foot of the hill for small-sized coal, and within it are gates and a trough, with grates for Egg and Stove coal. Schute No. 3 has a short empty car or transfer-plane for lifting 15 feet to the general upper level of the Loaded Track. For want of

room, No. 3 plane or schute is made to run under Schute No. 2, and therefore this additional lift of 15 feet. This is at right angles, and is done by a pushing-car; the weight of the loaded car acting through the drum and a lifting-shaft, to work a small drum at the head of the small transfer-plane. There is a spring and a beam at the top of the plane, in the edge of the drum-house which of itself comes on to the rail, and prevents the car from running down the plane.

Wire-ropes are used for the schutes; they are $1\frac{1}{4}$ inches in thickness; those for the large planes at the mines are $1\frac{3}{8}$ inches. They contain 36 wires of No. 14 wire. One foot weighs one lb. That of $1\frac{1}{4}$ inches diameter contains 6 strands of 19 wires each, or 114 wires; there is also a core or central rope of hemp; and here each strand has a wire-core, just as the English rope has a hempen core.

The Mount Pisgah Inclined Plane.—There are two engines at the head of this plane, working two drum-wheels geared to run in opposite directions, carrying the bands of the planes. These wheels are 27 feet in diameter, and are cogged on the periphery. The bands are two on each track; they consist of tough iron-plate, and each band is $6\frac{1}{2}$ inches wide, and $1\frac{1}{8}$ inches thick.

From the engine, a light shaft, geared by spur-gearing, works three pump-rods. Each pump has a different level on the side of the mountain, the water being lifted from the river.

Tunnels.—The Panther Creek tunnels have usually a fall of 6 inches to 100 feet.

Tunnel No. 5.—Its length is 849 feet, and about half-way in, it cuts Red-Ash coal 11 feet thick, with 3 feet of coal, the remainder being Bone-coal and slate. The dip is 70°. The coal has a twisted fracture. The total thickness of the Big Coal is 45 feet, with the same divisions as on the summit. There is rather more slate in the basin than on the summit.

The gangways are driven three-fourths of a mile Westward and one-fourth Eastward. The E. gangway of Tunnel No. 4 meets the W. of No. 5.

Tunnel No. 7.—The Big Coal is worked here, also the Red Ash. This tunnel enters Locust Mountain westward, a little W. of a point opposite Summit Hill.

Tunnel No. 8 (the longest in Panther Creek Valley).—It measures 1575 feet; the dip is about 42°. There are two or three small Red-Ash coals in this tunnel, and one at the mouth about 2 feet thick. The tunnel has a breast of 450 feet; the coal has been worked up 300 feet in some places. The gangways are driven 650 (yards?) both E. and W. It yields about three-fifths coal, and two-fifths dirt. It enters Locust Mountain westward opposite Slope No. 2.

The Red-Ash Vein in this tunnel is 7 feet thick, between slates, but will yield of good coal only 3 feet. It is the only Red-Ash coal worked here. The 11-feet coal above the large White-Ash Vein appears to be vein F. of Tamaqua and Greenwood Tunnel. The dip of the Big Coal is about 45°. The thickness at right angles to the coal is from 45 to 60 feet. This shows a considerable fluctuation in the thickness of this coal in short distances.

The Coal costs about $37\frac{1}{2}$ cents per ton to bring it from the mine; then about $12\frac{1}{2}$ cents to break and clean it. It then costs $12\frac{1}{2}$ cents to lift it to the summit, and run it to Mauch Chunk, and $12\frac{1}{2}$ cents more for other expenses. The engine of No. 8 Breaker is 20 horse-power. It hauls the coal up from tunnel-level to Breaker. Other Breakers have usually 10-horse-power engines. The Tunnel No. 8 is 13 feet wide, 8 feet high, has a double track at its mouth, and turn-outs within. The rails in the tunnel are of half-inch iron on wooden sleepers. One mule brings out three loaded cars.

Tunnel No. 9.—This important tunnel, designed to give access to the Big Coal dipping Northward from the anticlinal of Summit Hill into the main South basin of Panther Creek, or basin *B*, starts from a little above the water-level of Panther Creek, near Coaldale, and extends Southward about 2000 feet. It is the longest tunnel of this valley, and is one of the greatest in the coal region. It was begun in 1852. Not far from its mouth it passes the anticlinal axis A, cutting one or two of the Red-Ash coals. Farther in, it encounters the synclinal axis of basin *B*, where, as already mentioned, the crushed condition of the strata caused an extensive caving-in of all the materials above the tunnel-level to the surface, a height of some 80 feet. Beyond this synclinal turn the strata are regular the whole way to the conglomerate beyond the end of the tunnel, their dip being to the N. at a steep angle, averaging 55°. This farther half of the tunnel intersects the lower Red-Ash coals, the two Grey-Ash beds, and the Great White-Ash or Big coal, in which the excavation terminates. The mass of coal which it gives access to is very great, the Big coal presenting here a total thickness of more than 50 feet, and a length of breast or slant height between the tunnel and its outcrop, on the brow of Summit Hill, estimated at not less than 600 (?) feet.

Slope No. 2.—This is on the N. outcrop of the Summit Basin. It is about 243 feet to the water-level of the tunnel, then 10 feet of gangway, and 213 feet farther to the foot of the slope: the dip is about 37° S.

The machinery and openings *permit* a daily product of 1000 tons; the actual daily product is seldom so great. There are two engines of 40 horse-power each, for pumping and lifting the coal, and two others for the Breaker, of 10 horse-power each.

It is stated that the actual cost of lifting the coal from Panther Creek to Summit Hill is about four cents per ton; the lift, about 600 feet, is accomplished by two planes. This includes interest on planes, &c.

The coal of the N. side of basin is not quite so pure from slate as at the Summit Mine, and going still farther N. to the Beaver Meadow, the parting-slates are still thicker, but the coal there is somewhat purer.

The Lehigh Company has a capital of 7,000,000 dollars. This, and all their earnings since 1841, has been absorbed in extensions. The stockholders have in this interval received no interest. Their calculation for paying an interest was based upon coal selling at 5 dollars per ton in Philadelphia. It is generally below this price. The Company owns in all 20,000 acres, of which 15,000 lie in one body, extending Eastward from the Little Schuylkill at Tamaqua, to nearly 2 miles E. of the Lehigh, at Mauch Chunk. The other 5,000 acres are scattered up and down the Lehigh Valley.

CHAPTER III.

TAMAQUA.

COALS AND COAL-MEASURES.

In 1852 and 1853, when the whole S. anthracite field underwent a critical revision by the Survey, this locality was carefully studied, topographically and geologically, and, as in so many other localities, minute measurement of the strata instituted, and notes taken for the construction of an accurate Section. As now engraved, this Section embodies nearly all the data essential to a clear understanding of the structure and resources of this portion of the coal-field, except those which relate to the coals, as these are developed in the mines, and those of the mining statistics. The reader is therefore recommended to examine the Section for information not included in the following descriptions, which embrace rather the coals themselves than the rocks between them.

The fine natural section of the Coal-measures at Tamaqua, exposed by the transverse trend through the basin occupied by the Little Schuylkill, aided now by multiplied artificial mining openings, permits us to recognise almost every member of the large series of coals contained there. Above the main or lowest Seral conglomerate occurs, *first*, a group of *Eight White-Ash Coals*, the five lowest being separated respectively by coarse Nut-conglomerates with sandstones and shales, and the succeeding ones by less pebbly rocks. Between the lowest of these coals and the uppermost of the Umbral rocks, the Seral conglomerate group proper has a thickness of not less than 200 feet. The eight beds referred to terminate with the thick and noble seam designated by the letter E. Above this largest of the series, at an interval of more than 230 feet, succeeds the coal F, the first of the true Grey-Ash beds ; and about 80 feet above this is the so-called Bony Coal, the second and last of the proper Grey-Ash group. Next in order is the Red-Ash Vein, so called, the lowest of the true Red-Ash class, of which we may count at Tamaqua not fewer than seven or eight. Thus the whole series amounts to seventeen or eighteen beds, the chief of which possess qualities and dimensions well fitting them for mining and for the market.

On the S. side of the basin only, the lowest thirteen or fourteen of these coals present themselves, dipping almost perpendicularly in the Sharp Mountain, and in the slope at its N. base. A crushed synclinal fold in the latter position repeats the higher members of this group in a steep S. dip, which gradually flattens until it is succeeded by the anticlinal axis of the S. edge of the town of Tamaqua—axis C. The main street of the town is not far from the next or second synclinal axis, which contains probably about the eighteenth coal, or four or five beds higher in the series than have been preserved at the foot of the Sharp Mountain. The anticlinal between these two troughs lifts apparently about the tenth or eleventh coal to the water-level of the stream, where the arch is visible. There are some indications of an anticlinal, or a disturbance at least of the regular S. dip, between the S. anticlinal of the town and the synclinal at the foot of the Sharp Mountain ; and this, if proved, would alter somewhat our estimate of the number of coals lifted on the axis at the stream. It is obvious, on any view, that the

synclinal of the central street of Tamaqua must hold coals which are among the highest in the district, as our Section at Tamaqua will show.

North of the synclinal axis of the main street are two others, visible on the road on the E. side of the Little Schuylkill. The first of these passes about 700 feet N. of the road leading towards Mauch Chunk, and the other is 900 feet N. from this one. In the most Northern of these troughs, the fourth in order, the Coal-measures embraced are about as high in the series as those of the second, or that of the main street of the town, there being about seventeen seams visible between the synclinal axis and the conglomerate in Locust Mountain, underlying all the known Coal-measures, counting two pairs of double beds as single ones. Between the second and this fourth synclinal, the Coal-measures undulating over the second and third anticlinals, and in the third synclinal, belong to about one and the same place in the formation, the coals which they include being about the fourteenth and fifteenth of our enumeration from the bottom. The three anticlinals all lift the lower Red-Ash coals to the surface, and may be regarded as constituting a central undulated belt, having a synclinal belt or trough on each side of it, one at the foot of the Sharp Mountain, the other at the base of the Locust Ridge.

It is obvious that the Lower or White-Ash coals, which outcrop in the confronting sides of these two mountain-ridges, undulate in basining under the whole valley, in conformity with these superficial central flexures; but, for the reasons elsewhere explained, I do not think it probable that they undulate as abruptly, or in folds as much compressed, as do the upper, less constrained, and more flexible strata. In viewing all such sections, it is important to keep in mind this probable absence of parallelism in the curves of the outer and the inner or deeper-seated beds, involved in compressed and corrugated synclinal zones like this of the Pottsville Basin.

I proceed to trace, under a new head, these Tamaqua anticlinals, and their basins, Westward to Tuscarora, but shall first present here a subordinate chapter on the details of the coal-seams themselves, as they have been developed in the mines at Tamaqua.

The estate of the Little Schuylkill Company extends Eastward from the river along the N. half of the coal-field for nearly 2 miles, and embraces the whole basin Westward from the river to a line W. of Bucksville. This corporation, after developing its coal-field by tunneling the strata and constructing branch railways, leases its mines to competent contractors, and looks for profit to the large rental to which it is entitled from its very valuable coal-beds. At an early day in the history of its operations, before these coals, outcropping on the opposite sides of the general basin, were identified, every outcrop was named as if it pertained to a separate and independent vein or deposit, and they were designated by the letters of the alphabet, commencing with the lowest then known in the Locust Mountain, and proceeding regularly Southward, irrespective of repetitions by flexure. Thus it happens that the Coals A, B, C, D, D cross-cut, E and F of the N. side of the basin are the equivalents of the Coals T, S, R, QQ, Q, and O of the S. side, or Sharp Mountain. Above these the Red-Ash coals of the two outcrops have not been satisfactorily identified.

Individual Coal-seams.—Immediately below each seam of coal there usually lies the common sandy shale of the Anthracite measures, but the almost invariable covering of the coal is a sandstone. In only one instance does a shale fill up the entire space between two adjacent beds, and this is between QQ and Q in the Sharp Mountain, and their equivalents in the Locust Mountain, D, and D cross-cut. In the one case the dividing shale is 6 feet thick, in the other it is 12 feet.

COALS ON THE NORTH SIDE OF THE BASIN AT THE FOOT OF LOCUST MOUNTAIN.

Coal A.—The bottom rock of this bed is a heavy Nut-conglomerate. The vein has a breast of 700 feet. At the river the dip is about 65° S. The whole coal-bed is about 16 feet thick at the river. It is not worked to the E., and we were informed that it never has been in that direction. The gangway is in, about 1500 feet to the W., and the coal seems to be all in one body, or to contain no parting slate, but it is a good deal fissured and rubbed. Outcrops of three veins have been found north of Coal A, but of these nothing is critically known. Between Coal A and the next seam, B, the horizontal distance on the N. side of the coal-field is 260 feet, and on the S. side, where the dip is steeper, it is 202 feet, filled chiefly with silicious conglomerate.

Coal B.—Is not opened on the E. side of Tamaqua Gap. On the W. side it dips about 65° S., judging by the rocks. The average thickness near the river is about 9 feet. On the mountain it is more than 12½ feet. It crops out N. of the first ledge of conglomerate, about half-way up the N. slope of Locust Mountain.

Coal C.—Was in 1853 worked by a drift on the E. side of the stream; it was driven in 150 yards. It was faulty on the E. side, and was not more than 6 or 7 feet thick. On the W. side it had been driven about 900 feet, and was 8 or 9 feet thick, thickening as it went Westward. The dip at the river is from 55° to 58° S.

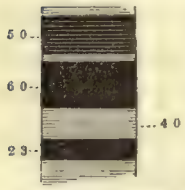


Fig. 143.—Coal C of Tamaqua.

Coal D.—This is the Big Slope Vein of Eaton and Carter, on the E. side of river. Its thickness on the W. side exceeds 14 feet; on the E. it is 12 feet. The gangways from the foot of the slope were, in 1853, driven 600 feet E., and the same distance W. An old upper-level gangway had been driven E. 1400 yards to a rock-fault, which heaved the vein off to the S.E. This vein on the W. side had been driven through to Reinhardt's Run on the top level. The coal was pretty much the same on the top level as it is on the E. side, both in quality and thickness, but it flattens in its dip, which, at Reinhardt's Run, is only 42°. The height of the breast is 280 feet from the upper coal, but in the hill it is 420 feet.

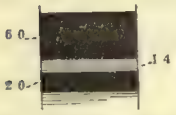


Fig. 144.—Coal D of Tamaqua.

The Cross-Cut Coal.—This bed is only 12 feet N. of Coal E, but at Reinhardt's Run it is 45 feet. It is supposed by some to be the principal vein at Bucksville. At Reinhardt's Run it is 2½ feet thick. At Greenwood Tunnel it is 10 feet thick, but its more permanent average size is 4 or 5 feet.

Coal E.—This has been opened on each side of the river. The portion called E East measures between the roof and floor about 23 or 24 feet, of which about 12 feet are very good coal, and the residue is Bony coal and slate. This coal is harder than that of D, but from the larger proportion of inferior coal in the bed, it demands more attention in the preparation for market. E West is a softer coal than E East, the whole bed lying looser between its confining strata. It is hence somewhat more dirty. It has been wrought with great facility, but in a manner not unattended with danger, in consequence of the somewhat loose state of the bed, or want of close compression between the roof and floor. It is wrought in successive levels. At distances of 150 feet along the horizontal gangways, schutes are carried up from one gangway to the next higher, leaving massive pillars of untouched coal between, the roof and coal in the

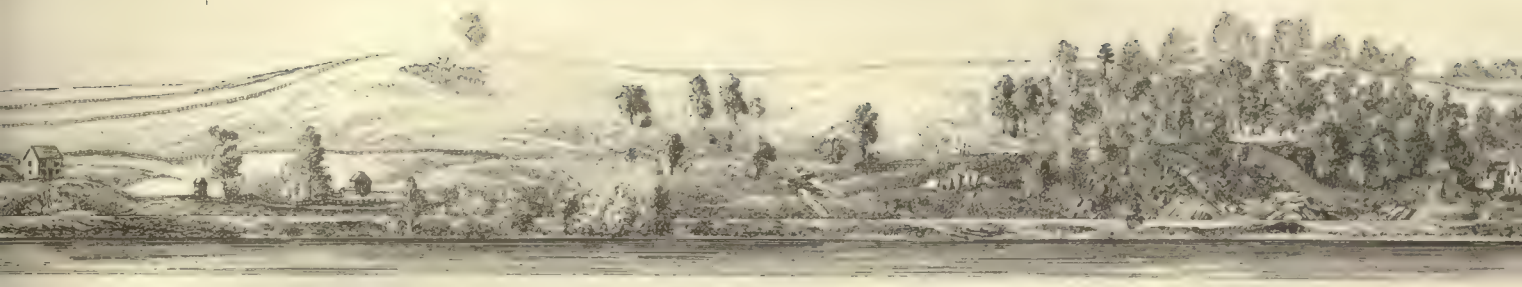
ctorial Section of East Bank of the Schuylkill from Spring Mill to Manayunk

H o r n b l e n d i c G n e i s s

Granite vein

D i l u v i u m o f M e s o z o i c R e d S a n d

S l a t e a n d G n e i s s.

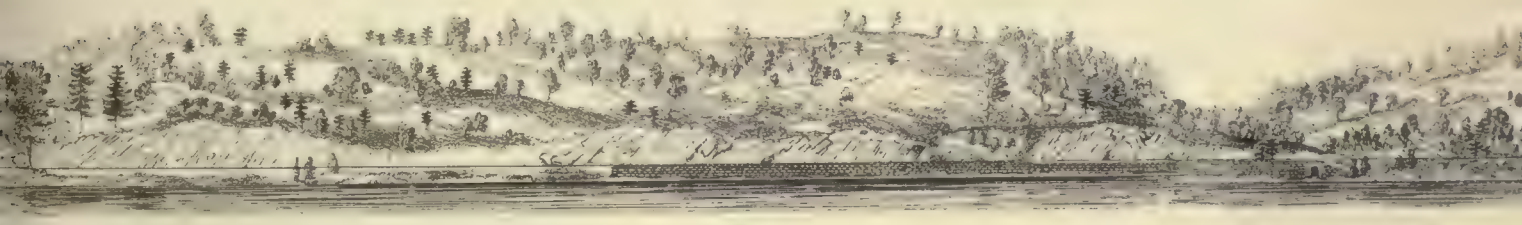


Apparent junction of Gneissic and Palæozoic Strata

Gneissic Rocks

Stratic dyke

ne and Primal White Sandstone



Garnetiferous Mica

Engraved by W. & A. K. Johnston Edinb

breast above being supported in the usual manner by pillars of wood transverse to the bed, and by a strong floor of plank to hold up the coal. Such is the shattered condition of the whole mass in some parts of the mine, that as fast as the miner picks away the coal next the bottom-slate, other coal from above presses into its place; thus assisted by the freedom of the coal, the workmen in two adjacent schutes can sometimes empty all the coal from the space between them. This fragmentary condition of the coal extends to the outcrop, for in one place at the surface, an enormous hole was at one time formed, 60 feet and more in length, and at least 40 in breadth, by the mere sinking-in of the loose coal as it was withdrawn below within the mine. The dip of this bed is about 54°, that of the opposite portion, E East, is 53°. Between the small intermediate coal-bed (D Cross-cut), and the bed E, the distance at right angles to the dip is about 53 feet.

On the W. side of the Little Schuylkill this thick coal-bed is mined through towards Reinhardt's Run, and towards the end of the year 1853 had reached Newkirk Tunnel. It usually contains three benches, but on the E. side it sometimes has four or five. Towards the W. this seam runs rather faulty, but E. it has been worked through to Greenwood Tunnel. Its average thickness is 22 feet.

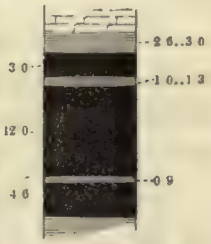


FIG. 145.—Coal E of Tamaqua.

Coal F.—The next vein, called F, formerly wrought only on the W. side of the stream, is now opened on both sides. At the level of the railroad the bed is in a somewhat crushed condition, and therefore the workings at this lower level have been for some years abandoned. This coal is in two benches. The bottom bench is the thickest on the E. side of the river, being from 6 to 7 feet. On the W. side it is 5 feet thick. The top bench is on the E. side from 7 to 8 feet thick, and on the W. side 6 feet. The lower bench is a pink-ash coal. The dip of this seam averages 60°. Its horizontal distance from Coal E is 270 feet.

The Bony Coal.—This is 138 feet S. of Coal F, at Tamaqua; it is there 6 feet thick.

Red-Ash Vein.—This bed, in horizontal distance, is 100 feet S. of the Bony Coal; it is 3 feet thick.

Coal J, or Jock Vein.—At a distance of 120 feet S. of the so-called Red-Ash Vein occurs the coal-seam J, measuring at its outcrop, which is somewhat faulty, between 6 and 7 feet.

First Twin Coals.—S. of coal J, 48 feet, are two thin beds, 15 feet asunder; they have never been fully opened.

Second Twin Coals.—Distant from the last pair of thin seams is another pair, also about 15 feet asunder. These likewise have never been mined, for they expose too low a breast above the water-level, and they are too thin and worthless to justify mining by pit or slope. Their dip, and that of the strata adjoining them, is 75°.

Upper Red-Ash Coals.—At a distance of 217 feet S. of the Second Twin Coals, we meet the first of a group of three nearly perpendicular seams, which, being near the synclinal turn of the basin, may be called, for distinction's sake, the Upper Red-Ash Group, a term warranted by the great thickness of barren strata which separates them from the group beneath. The *first* of these is about 4 feet thick, though it has never been mined far enough to prove its permanent dimensions. The *second*, 116 feet S. of the first, and divided from it by a rather coarse sandstone, is 3 feet thick. Both of these coals are somewhat crushed or "dirty," a condition which belongs indeed more or less to all the Red-Ash series of the central belt of this part of the basin. The *third* Upper Red-

Ash coal is still thinner, but dipping at an angle of 80° S. : it is very probably in a squeezed state.

Synclinal Axis of Basin B.—The exposures, natural and artificial, on the E. side of the Little Schuylkill, reveal very distinctly the sharp synclinal fold or axis of the N. basin. It shows the strata—slate and argillaceous sandstone—closely compressed into a sharp V, the point or axis of which is 240 feet S. of the last-mentioned uppermost Red-Ash coal.

The three thin Upper Red-Ash coals appear to repeat themselves on the S. side of the synclinal axis, at distances somewhat less than those which separate them on the N. ; they dip almost perpendicularly, and appear to be very thin—all three circumstances implying that they are squeezed and faulty from proximity to the very sharp and compressed Anticlinal B, which bounds their basin.

Anticlinal B.—The distance of this axis from the centre of the synclinal basin N. of it is 544 feet.

A thin coal, probably one of the Second Twin seams, occurs close to the axis, dipping both ways, and it reappears on the two corresponding sides of the next anticlinal, B, but at a wider distance from that axis. It should be observed, however, that the identification of these thin, faulty, and imperfectly-opened coal-beds is attended with much uncertainty.

Anticlinal Axis B.—This central axis of the coal-field at Tamaqua, already described as crossing the Little Schuylkill just N. of the town, is distant from the first, B, 567 feet, and the synclinal axis between them, belonging to the very closely-compressed basin *B b*, ranges S. of axis B about 305 feet. This anticlinal B, lifting very nearly the same rocks to the surface as the saddle N. of it, is even more compressed, its N. dips being 85°, while its S. ones are as steep as 65°. Two coal-beds appear on the S. flank of this saddle just N. of Tamaqua. The lower one is apparently between 5 and 6 feet thick ; the upper one, distant from it about 105 feet, is only 15 inches.

A deep excavation of the coal-rocks, filled up to a level plain by diluvial matter, conceals the native rock under the town of Tamaqua, through a breadth of about 600 feet; but just S. of the village, rock-exposures occur again just at the anticlinal axis C at the E. foot of the hill upon which the S. skirt of the village rests. This anticlinal is distant from the middle axis B 891 feet. The synclinal axis *C b* is probably about 400 feet N. of the S. saddle, and directly under the town.

From the S. anticlinal C to the first distinctly-opened coal-seam of the basin *B* of the valley at the foot of Sharp Mountain is a wide space of 740 feet, within which the strata are very imperfectly recognisable. This interval is apparently occupied by South-dipping Coal-measures, containing doubtless two or three of the lower Red-Ash coals. To the S. of the blank space a succession of very steeply-dipping coals is met with : the first three of these dip at angles from 65°—80° S. These are all crushed, and their true thicknesses, therefore, are not determinable. Beyond the third of these South-dipping beds, we come, at an interval of 70 feet, to a perpendicular seam, called K by the proprietors. This probably pertains to the Sharp Mountain series, or, in other words, seems to belong to the S. side of the basin *D*.

Synclinal Axis of Basin D.—It has been impossible to determine with precision the position of the synclinal axis of basin *D* at the foot of the Sharp Mountain, but my impression is, that it lies either immediately N. of the coal-bed K, or of the coal next N. of it. Assuming it to have

the latter position, its distance S. of the anticlinal axis C is about 865 feet. Whatever be its exact place, it is an extremely close fold of the strata; and there can be little prospect of continuously sound workable coal in the three or four lower Red-Ash beds immediately involved in it near the surface. Upon the supposition I have made, the total number of separate coal-seams S. of the synclinal axis, or belonging to the S. outcrop of basin *D*, including the two conglomerate coals underneath coal A, or its equivalent, is just fifteen. This number is less by two than the South-dipping series of the Locust Mountain side of the coal-field N. of the synclinal axis *B*—a difference to be anticipated from the obvious fact, that the anticlinal C—that of Mine Hill—is a stronger wave, with greater vertical uplift than the saddle B, which belongs to the feebler undulation of the Summit Hill.

From the coal-seam K, Southward to the lowest bed opened in Sharp Mountain, we cross a succession of well-proved Red, Grey, and White-Ash coals, the exact equivalents of the South-dipping beds in and S. of Locust Mountain. Comparing the Grey and White-Ash seams of the two sides of the valley, the coal M, 5 feet thick at the foot of Sharp Mountain, is the equivalent of coal J; and N, the opposite outcrop of the so-called Red-Ash bed; coal o, 7 feet thick, the representative of the Bony seam; coal O, 10 feet thick, that of F, also 10 feet thick; coal P, 22 feet thick, of E, which is also 22 feet; Q, 8 or 9 feet thick, that of the Cross-cut coal, 4 or 5 feet thick; Q Q, 8 feet, but variable, of D, which is 15 feet thick; coal R, 9 feet thick, of C, 7 or 8 feet thick; coal S, 7 feet, the counterpart of coal B; and coal T, the equivalent of coal A.

Coal K.—this seam is much crushed and faulty, and has never been profitable. It yields between 4 and 5 feet of bruised Red-Ash coal. Its dip is a little to the S. of the perpendicular.

Coal L is a small and much-crushed seam, which has never been wrought.

Coal M.—This vein is also much disturbed, there having been obviously an extensive movement in the plane of the coal-bed itself, for in some places it is pinched to the dimensions of 3 feet, and then it expands to even 9 feet, and thus throughout all the extent to which it has been wrought. It has a very nearly perpendicular dip. Its distance from coal K is 159 feet. It has furnished some very good coal, but has never, in the main, been a profitable mine.

Coal N is distant from M, the last mentioned, 112 feet. It also is a much disturbed stratum, yielding but little good coal. Its dimensions are about 2½ feet. The dip, always very steep, is irregular, showing a movement in the plane of the bed.

Coal O o.—This coal we could not enter at the time of our explorations, in consequence of the dangerous and obstructed condition of the gangway. It was reported to us as 9 feet thick, but the coal was bruised, and of little value. At the mouth of the drift the dip is a little to the N. of the perpendicular. It lies S. of coal N about 150 feet.

Coal O.—About 50 feet S. of the last named lies the seam called O. At the mouth of the drift the dip of the bed is somewhat irregular, but steep; farther into the hill Westward its slope is 53° N. Like all the Sharp Mountain beds, this coal has experienced a sliding movement in the plane of the dip; and the coal is therefore more or less crushed and fragmentary, although it has really afforded a sufficient proportion of marketable coal to defray the cost of mining. It is alleged to be 10 feet thick.

These previously-enumerated coals of the Sharp Mountain series all yield a reddish ash, that of the last enumerated being the palest. With the next seam commences the White-Ash group of the Sharp Mountain coals.

Coal P.—This is the S. outcrop of the great bed of the basin. For several hundred feet in from the mouth of the drift its prevailing size was 22 feet, but it is stated to have expanded in one locality in the mine to 42 feet. At its outcrop on the mountain-side it measures about 23 feet.

Perhaps not more than one half of the coal in the bed is adapted to the market, the rest being of the earthy sort called Bone coal. It position is about 193 feet S. of the last described, and its dip is from 75° to 80° N. It is now mined below the water-level on the W. side of the river, by a shaft sunk to meet it at a moderate depth below its water-level outcrop.

Coal Q.—Distant about 75 feet from the large bed P lies another coal, called Q, the average thickness of which is 6 feet 6 inches. This is considered to be the best coal in Tamaqua. Its dip, the same as that of P, is 75°. This bed was wrought in the usual mode from the lower levels upwards by schutes. In one spot, after being mined towards the outcrop a distance of 300 feet, the greater looseness of the coal in the higher portions caused it suddenly to rush in from the top, costing the lives of three miners. In the enormous movements which all the Sharp Mountain strata have undergone, when they were elevated from their original horizontal posture into their present nearly vertical dips, they evidently underwent an enormous unequal pressure, squeezing them greatly in certain portions, but loosening and displacing them in others where the cohesion was feeblest.

The several coal-seams and their slates being the least coherent and most easily crushed members of the ponderous body of strata, any sliding of the mass during upheaval was necessarily greatest within the materials of these softer layers, and in the plane of their slope. Hence the fragmentary condition of so much of the coal in the Sharp Mountain, the elevation of which seems to have been attended, even in the district of the Little Schuylkill, with the production of an enormous compression of the rocks near its N. base. These views should be daily in the thoughts of those who are working the Sharp Mountain coals, for as the mining operations there advance, the danger to life and property must inevitably increase.

Coal Q Q.—At the level of the railroad the space between this seam and Q, the last described, is not more than about 7 feet, but at a counter-level 220 feet higher they are separated by 12½ feet of slate. They are both entered by one external drift. The bed Q Q measures between the bottom and top slates about 7 feet, and it turns out 4 feet of good coal, except in those places where it is crushed.

Coal R.—This seam, which is stated to have a thickness of 9 feet, lies S. of Q Q 205 feet. It was originally entered by a drift at the level of the railroad; but the workings on this level were arrested by an oblique fault bringing against the end of the drift a mass of slate dipping towards the W. It has been since penetrated in another more successful drift, at an elevation of nearly 300 feet above the former. Some of the coal of this bed is very beautiful.

Coal S.—The workings upon this vein were at the period of our investigations so dilapidated as to preclude the determination of its dimensions, but it is stated to be 7 feet thick. It is obviously not a sound nor valuable seam. Some of the coal appeared to be of a good quality, but the bed is too soft and shattered to prove profitable. Its distance from the main upper layer of the Seral conglomerate, which forms the crest or backbone of the Sharp Mountain, is about 202 feet, and its dip is about 70° to the N.

The total thickness of the productive Coal-measures at the Little Schuylkill, counting from

the synclinal axis *B* to the bottom of coal A, is apparently about 2000 feet. As basin *B* is probably the deepest of the four caused by the three anticlinals, it is obvious that 2000 feet is the maximum depth at which coal A can lie anywhere beneath the surface of the valley. A shaft or a deep subterranean tunnel of that length will therefore cut all the fifteen coal-seams to A inclusive, and one about 1300 feet long should reach the thick and valuable coal E. Of course, shallower pits and shorter tunnels will penetrate to the same coal-beds in the basins *B b*, *C b*, and *D*, and still less extensive ones on the anticlinal axes B, B, and C, though the anticlinals are seldom the most suitable belts in which to sink deep shafts. Probably the most economical mode of reaching a large amount of sound coal beneath the water-level will be found to be, for a long time to come, by slope-pits sunk in coals E or D, and by a tunnel driven N. and S. from the bottom of the slope. Indeed, this process is employed, in the present time, at relatively superficial levels. Our panorama sketch of the collieries exhibits the exterior arrangements connected with a slope-mine in coal D. Ultimately it may be found desirable to sink one or more perpendicular shafts near the middle of the coal-field, and then, more probably, basin *B b* or *C b* will be chosen as admitting of the most entire command of the deeper-buried wealth of the region.

GREENWOOD TUNNEL.

At the first tributary of Panther Creek, E. of the Little Schuylkill and about a mile from Tamaqua, the South-dipping strata on the N. side of the Locust Mountain basin, or that bounded on the S. by the Summit Hill anticlinal, are penetrated Northward by an extensive tunnel, the opening of the Greenwood Mines. This tunnel has its mouth in the Red-Ash Coal-measures, about 300 feet N. of the synclinal axis of the Locust Mountain basin. A little more than half-way in, it cuts the lower Red-Ash coal F, and then E, the Cross-cut, and D in succession, terminating, at the time we saw it, in the latter. The rocks at the mouth of the tunnel—grey pebbly sandstones—dip 45° S. 20° E. The immediate entrance is in slate. (For Section of Tunnel, see woodcut, fig. 146.)

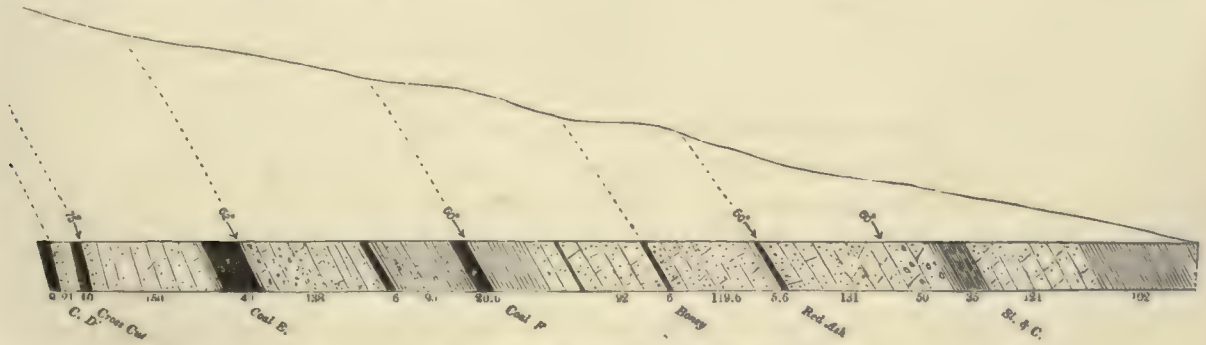


Fig. 146.—Greenwood Tunnel, in Locust Mountain.

The first coal cut in the tunnel is the small Red-Ash bed S. of the Bony coal, and then the Bony coal. The vein F has been mined Eastward about a mile and a half in the tunnel-level. A slope-mine enters it at Carter's New Slope, 3000 feet E. of Greenwood Tunnel. The bed is there from 12 to 15 feet thick, and dips 50° S. Its ash is pinkish grey and white.

CHAPTER IV.

THE SCHUYLKILL OR CENTRAL DISTRICT OF THE COAL-FIELD.

INTRODUCTORY DESCRIPTION.

Before proceeding further to describe in detail the structure and contents of the coal-field, it is expedient to present a geographical sketch of the great Middle Division of the Southern basin, or that which is drained by the waters of the Schuylkill, and which has Pottsville for its centre. This extends to Tuscarora on the E., and to the sources of the West Branch, Schaffer's Run, and Muddy Branch on the W. It embraces the widest portion of the basin—that in which we find the greatest amount of irregularity in the position of the strata, and where the largest number of active collieries are assembled. It is therefore the most intricate and important of all the mining districts within the anthracite region. It will be seen, on inspecting the Map, that this district, drained by the waters of the Schuylkill, constitutes a very natural subdivision of the basin. The rising of Mine Hill, near Tuscarora, almost into the centre of the valley, and the abrupt change of position to the S. of the Sharp Mountain near Middleport, cause it to be partially insulated from the Eastern narrower end, while on the W. the throwing forward to the S. of the flank of the Broad Mountain beyond the West-West Branch, seems, though in a less marked degree, to divide it from the district watered by the sources of the Swatara.

In its topographical structure this part of the basin is admirably adapted for the extensive and easy development of its mineral breadth. The whole interior of the valley is traversed longitudinally by nearly parallel ridges and intervening depressions, produced by the combined agency of anticlinal folding of the strata, and the carving of the surface by denuding waters. These undulations amount to a difference of level of from 100 to nearly 400 feet. But there is a still more important feature favourable to the extraction of the coal: the entire district is intersected *transversely* by the tributary valleys of the Schuylkill, and by their subordinate ravines. The wild floods, which originally breached the notches in the mountains for the passage of the present rivers, in sweeping S. across this district, have formed a series of deep cross valleys, the chief of which traverse the whole breadth of the basin, while the minor ones penetrate from the S. side only to the middle and N. border of the valley. These great natural trenches, by intersecting the longitudinal ridges, give ready access to a multitude of coal-seams, which are entered endwise at various depths below their upper outcrops, so that extensive slopes or breasts of the coal are procurable above the water-levels, and therefore without the expense of mine-drainage by machinery. They are, furthermore, the natural excavations approximately graded for the reception of the numerous lateral or branch railroads by which the coal is conveyed from the mines into the great channel of trade from the district, the valley of the Main Schuylkill.

The most conspicuous of these transverse valleys are those of Mill Creek, the West Branch, and the West-West Branch. These enter the basin from the Broad Mountain, breach the axis of Mine Hill, and traverse the valley to the very base of the Sharp Mountain. The Eastern Branch of the Schuylkill, from Tuscarora westward to Pottsville, along the S. border of the basin at the foot of the Sharp Mountain, is the main trunk of an extensive series of such subordinate transverse ravines,

which, commencing in the N. side of the field at the base of Mine Hill, and the lesser ones in the middle of the valley, open Southward into it as their natural outlet. Advancing W. from Tuscarora, the first of the more conspicuous of these cross ravines is that of Big Creek, which stream rises in the little valley between the Locust Mountain and Mine Hill, and in passing the subsiding axis of this latter, lays naked an extensive body of Coal-measures. The next is that of Casca William Run, upon which are several collieries.

It opens into the Schuylkill near the little village of Middleport. Further W. are the valleys of Lick Run and Lime Creek, upon both of which are now seated some promising collieries ; and beyond these occur two or three lesser valleys, and then the more extensive one of Zachariah's Run, the locality of several extensive mines. Another considerable ravine opens between this last and Mill Creek, upon which are also extensive collieries.

That important division of the district which is included between Mill Creek and the West Branch is penetrated throughout its entire breadth, from Pottsville to the flank of Mine Hill, by two other large valleys at right angles to the strata, those of East Norwegian and West Norwegian creeks. These unite N. of Pottsville, and the combined stream follows thence a single valley, directly transverse to the strata, to the main defile in the Sharp Mountain, where it joins the Schuylkill.

Nearly every valuable bed of coal intersected by the five principal transverse valleys of Mill Creek, East and West Norwegian, West Branch, and West-West Branch, has been opened, and has been, or is now, the seat of mining operations. Formerly the coal-workings were restricted to the portions above the level of the adjacent valley, but of late years extensive collieries have been established, in which the coal is wrought to already considerable depths below the water-level. Availing ourselves of the data thus supplied by artificial exposures of the strata, and combining with these the measurements of all the recognisable natural outcrops of the beds, we have succeeded in partially unravelling the structure of this excessively complicated district. I cannot pretend to exhibit here an entirely accurate representation of the course of every coal-seam, for in the present still infant state of development of this great coal-field, the materials are not yet discovered for the delineation of its many beds of coal in their intricate windings upon the surface, and their still more perplexing changes of dip and dislocation under ground. No one of the principal ravines crossing the basin supplies by any means all the facts essential for the construction of full general transverse sections of the strata representing the outcrops and the underground flexures of every coal-seam. I have been compelled, therefore, to resort to an extensive and laborious compilation of data gathered along the valleys of the Main Schuylkill and its tributaries, for materials for the several sections of the basin herewith presented.

ANTICLINALS AND BASINS BETWEEN TUSCARORA AND EAST NORWEGIAN.

Anticlinal D, *or Axis of South Mine Hill.*—Regarding the axis S. of Tuscarora as the E. prolongation of this conspicuous and important anticlinal, we may view it as originating in the N. flank of Sharp Mountain, somewhere S.E. of Tuscarora. We first recognise it W. of the valley of the Schuylkill, in the S. side of the hill next W. of that of Tuscarora, where it bounds Chadwick's Basin on the N. It crosses the Pottsville road near its abrupt bend Southward towards the Schuylkill, passes S. of Silliman's Breaker on Big Creek, and is the saddle which

until, at Johns' Colliery, the lower Great White-Ash coal, which at Silver Creek bends over the arch at a high level at Guiterman's former workings, does not much more than rise here to the bed of the valley. As this anticlinal encroaches in going Westward more and more upon the base of the Main Mine Hill, it leaves a less and less width and depth in the synclinals N. of it, so that that which at Casca William is a basin of some breadth and capacity, becomes, at Silver Creek and at Mill Creek, a mere rolling over, with more or less of fault, of the prevailing S. dips into a very narrow line of steep N. ones. As is very frequently the case, the flexure becomes more dislocated as it thus contracts in breadth, and degenerates into a more sharply-pinched fold.

Anticlinal E, *or Casca William Diamond and Northern St Clair Axis.* — The next anticlinal which presents itself in order Southward is one of less length and of gentler dips. Our first indications of it to the E. are in the watershed between Bushy and Casca William valleys. No N. dips at the first named of these valleys indicate its existence so far E. This axis passes Casca William Valley about 200 feet to the N. of the Slope Mine on the South Diamond coal, holding the Diamond group above the water-level of the district, from thence to Silver Creek, where the coal called the Big or North Diamond arches the axis, to rise again immediately behind it, and outcrop with its prevailing dip to the S. The line of the saddle crossing Silver Creek passes directly under the Public School-house, and thence through the watershed, dividing Silver Creek from Zachariah's Run, into which valley it descends along a ravine leading down to Windy Harbour. From this point the flexure seems to decline to the Westward, though, by its obliquity of direction as respects the general range of the coal-basin, it causes lower coals instead of higher ones to saddle in succession as it passes. Thus reaching the vicinity of Crow Hollow, it enters the district of the large upper White-Ash coal or Mammoth bed, where this is mined at and below the water-level; and it is the cause of the great and sudden change in the course of the gangways or levels of the mines in that vicinity, which, leaving their Eastward trend, swing Southward to pass round this flexure. Approaching Mill Creek, the anticlinal passes under the swell of hills S. of Milne's Slopes, undulating here the Big Vein in which it crosses the valley, to disturb the gentle Southward dip of the overlying Primrose Seam on the opposite side, or to the W. of St Clair.

Of the Basin C D, or that between the Main Mine Hill and the South Mine Hill.—This basin, lying immediately N. of the axis just described, embraces at Tuscarora, and thence Westward to near Big Creek, as we have seen, two subordinate saddles, or two chains of short interrupted saddles, undulating the lower Red-Ash Coal-measures. But at Big Creek, and from thence Westward, by virtue of the rising of the main axis of East Mine Hill, and the consequent lifting of the general basin, the Red-Ash coals are thrown out, except near the S. side of it, in the vicinity of that stream, and as far perhaps as Whitfield's; and beyond this latter locality to the Casca William Tunnel, it is doubtful if any but the Grey-Ash group are retained in the centre of the trough, while the uppermost coal left in the valley to the Westward of that tunnel is probably the upper Big White-Ash seam. At Silver Creek, not only this seam, but all the underlying beds until we reach the large one called Guiterman's, have been lifted and washed out from the contracted trough; and at Mill Creek it retains nothing higher than Johns' large bed, the equivalent, as we conceive, of the large seam over Guiterman's of Silver Creek, and there called Chadwick's.

Basin of Anticlinals D *and* E.—To understand the structure and contents of the basin at the S. foot of the S. ridge of Mine Hill from Casca William to Mill Creek, it is only necessary to consult and compare the several Sections which illustrate the region of this group of axes, and to observe that, in consequence of the greatly superior elevation and sharpness of the N. anticlinal D, compared with the S. one E, the two sides of the trough are of very unequal breadth and capacity as respects the coals elevated above the water-levels. The S. or lesser flexure operates, in fact, merely to undulate the upper strata of this basin in their descent towards the South, or to check and turn their prevailing S. dips for a brief space into N. ones. Thus at Casca William Valley, from the anticlinal D to the synclinal turn or axis, we have, in the space of some 1400 feet, all the coals presented in a gradually-declining dip from the large White-Ash seam to the Big or North Diamond; while from the synclinal line to the anticlinal E we have only a space of about 150 feet, and no return of any of these coals to the surface, except the uppermost or North Diamond itself. On Silver Creek we meet with even a greater disparity in the number of the beds presented on the two sides of the synclinal, the Northern, embracing the whole series of coals from the Guiterman bed, low down in the White-Ash measures to the North Diamond of the Red-Ash; whereas the Southern, precisely as at Casca William, re-elevates only the uppermost, which is here the North or Big Diamond. From the Northward trend of the basin, and its entering belts of lower and lower coals, we find it to contain, on Mill Creek, at or near the water-level, only the White-Ash Mammoth seam, and the overlying Grey-Ash Primrose, and its companion beds.

In different parts of this valuable synclinal range, the simplicity of the synclinal structure is interrupted by an occasional anticlinal roll, or short local saddle. One such is encountered just S. of the Casca William White-Ash Slope, and ranges for some distance parallel to the foot of the spur of South Mine Hill; but this undulation seems to smooth itself out before we reach Silver Creek, or even a point opposite the head of the Lick Run Ravine. In the same part of the basin there are indications, from the course of the outcrop of the Diamond coals, of a similar trivial axis South of the preceding. In the vicinity of Mill Creek, a broad gentle saddle of this sort arches the upper White-Ash coal, or the so-called Mammoth Vein, and near that valley even exposes by denudation an arch of the main Nut-conglomerate stratum which supports that coal. The position of this anticlinal is a few hundred feet S. of Johns' Breaker. The highest coal which it elevates is a small seam next under the Mammoth bed. This has been experimentally shafted just under the crown of the flat symmetrical arch. The evidence presented by various trial-shafts sunk on the flank of this ridge goes to indicate that the next subjacent coal-bed, the great White-Ash seam worked by Johns, is at or very near the surface in the line of the anticlinal. How far this saddle ranges to the E. has never been determined; but notwithstanding the exploratory diggings undertaken here by different parties, the coal within this saddle has not been satisfactorily traced, or, if ascertained, has not yet been divulged. That the saddle expires in a length of perhaps half a mile seems probable, from the most careful study which we have been able to give it. This flexure is felt to a less extent on the W. side of the valley of Mill Creek, flattening and extending the breast of Pinkerton's Mammoth Vein between its outcropping and the level of the valley.

Anticlinal F, *the Patterson and St Clair Axis.*—We now come to another and leading

anticlinal, extending the whole way from the vicinity of Tuscarora to Mill Creek and East Norwegian. It seems to originate in the shoulder of Sharp Mountain, E. of the depression opposite Beachem's Lower Tunnel, and it ranges thence by the Schuylkill and a little S. of Patterson, where both its N. and its S. dips are easily discoverable. From Patterson we may trace the line of this anticlinal through the De Long tract, and across the Bushy Valley, where it arches the Adam Stahl coal-bed, and again past the valley of Casca William, where it seems to lift to a higher level the same coal-bed. From Casca William we have traced it through Lick Run, where it passes N. of the massive bed of lower conglomerate exposed on the old railroad above the most Northern of the Mine Drifts of that valley. It ranges to Silver Creek through Quigley's Hollow, and, crossing the hill W. of this, appears at the main valley of Silver Creek as the anticlinal which rises on the centre of the double fold of conglomerate cut by Tucker's Switch-back railroad. On the W. side of Silver Creek it is to be detected in the low spur which is next S. of the ridge sustaining the School-house, and, rising and expanding Westward, it comes out on Zachariah's Run just to the N. of the folded synclinal coal-bed of Windy Harbour. Though some obscurity attends the detailed tracing of this axis for some distance further forward, our researches leave but little room to doubt that this is the anticlinal of the N. base of the spur which separates Crow Hollow from Ravensdale, and which is met with in the N. end of Ravensdale Tunnel in the form of an inverted flexure, doubling the Primrose Vein backward under itself. At Mill Creek it is traceable by the saddle which passes a little N. of the line of Carey's Shaft, and which there lifts the Primrose Coal to its shallow position in that shaft, throwing out the Orchard Vein altogether from the low grounds to the N. of the hill. From Patterson to Silver Creek this flexure is of a normal form, or but moderately compressed; but Westward it seems to be more closely folded, the inflexion reaching to a strong reversal of the dip in the Ravensdale Tunnel. Beyond this point it rights itself, and rapidly dilates and subsides, until at Mill Creek and East Norwegian it is but a gentle and symmetrical undulation, scarcely noticeable as a part of a great leading anticlinal.

Coal lifted by Axis F.—Adverting now to the coal-beds which this anticlinal makes accessible at the surface, we may mention that the Adam Stahl Vein, brought out by it on the De Long and Bushy tracts, is in all probability one of the seams of the middle Red-Ash series somewhere above the upper Diamond, but by how many terms separated it is not possible to say. On Silver Creek this axis brings above the water-level of that valley about the fifth coal above the Big or North Diamond inclusive, and, at Zachariah's Run, most probably the second coal below this fifth, or possibly the South Diamond. At Ravensdale and Crow Hollow the coal which saddles the axis is, as we have seen, the Primrose; while on the W. side of Mill Creek, as already shown, it throws out the Orchard, and brings the still subjacent Primrose nearly to the surface.

The D F and E F Basin, or that of Patterson and St Clair.—From Beachem's Mines, in Sharp Mountain, to the Bushy Valley, there is but one basin embraced between the anticlinals F and D, if we except a local subdivision of this to the Eastward, arising from the intrusion of the short saddle D; and the general synclinal line of this comparatively broad field ranges a little to the N. of Patterson, the axis of the trough being visible on the road between Beachem's Lower Tunnel and the village of Brockville. But from Casca William Creek to Mill Creek the intro-

duction of the axis E greatly narrows the basin lying to the N. of our anticlinal F, the average breadth of which nowhere amounts to more than from 800 to 1000 feet. From Patterson, as far Westward as Casca William, the middle Red-Ash coals evidently lie within the synclinal belt, and at Silver Creek we have the fifth above the North Diamond inclusive, the same which spans the axis S. Even as far as Ravensdale and Crow Hollow the Diamond coals are embraced within this basin—at least they bear this name there—and the coals actually belonging to it cannot be far from the Lower Diamond. It is not till we come to Mill Creek that all the Red-Ash coals are lifted out of the now narrow and shallow trough, and that the Grey-Ash seams, the Primrose and Orchard beds only, are left undenuded in its gentle synclinal wave. It is into this basin that the Casca William Red-Ash slope on the South Diamond penetrates, and it is this which contains on Silver Creek the North and South Diamond slopes of Mr Neill. In this basin the Mammoth Vein, held up by the anticlinal E, is entered at Crow Hollow by Silliman's Water-Level Tunnel, and this is the basin of the present lower slope-workings of the Mammoth Vein both E. and W. of Mill Creek. Carey's Shaft penetrates to that vein at a depth of 400 feet, in the basin next to the S. of this, or that which we have called F G, but the anticlinal F being here a very gentle one, no obstacle of importance will be presented to the working of this valuable coal-bed from the one basin into the other.

Subordinate Anticlinals D *and* D D.—The basin on the N. of our anticlinal F contains, as already mentioned, a short saddle, which, from its lying most contiguous to the axis D, is entitled D. This is a sharp or compressed axis, running from the Schuylkill, where it first shows itself about half a mile below Tuscarora, for about one mile to the Westward, crossing the Pottsville Road a few hundred yards to the N.E. of Brockville. It is the saddle to which belongs the perpendicular or slightly-inverted dips at Chadwick's Little Breaker, the anticlinal axis being obviously but a short distance to the S. of this: the N. dips seen on the road N.E. of Brockville are also connected with it.

The *Basin* composed of these N. dips of the saddle, and the gentler, though still steep ones of the anticlinal D north of it, is that in which Chadwick has recently opened a small colliery in one of the Red-Ash veins, basining at the centre under the water-level; but of what precise coal of the series this is the equivalent, the imperfect developments of the coal-field preclude us from ascertaining.

Saddle D D.—There is, in the N. part of the Bushy Valley, a small saddle about the middle of the synclinal belt *D F*, on the parallel of the lower Red-Ash coals, which, for facility of reference, we may call D D. It has not been traced any distance either E. or W. of the valley, and we only know that it is an important local disturbance of the Coal-measures.

Axis G—Anticlinal of the Silver Creek Switch-back Railroad and of South St Clair.—This is an anticlinal axis holding a distance of from 800 to 1000 feet S. of the long axis F, which it does not, however, seem to accompany much further Eastward than Silver Creek or Lick Run. It is possible that it may cross Lick Run, though the exposures and developments are there too obscure to enable us to decide positively respecting its existence. The magnitude of this flexure on Silver Creek would seem to imply that it is there already a considerable distance from its commencement. It crosses Silver Creek S. of Quigley Hollow, and a little N. of the great bend of the Silver Creek Switch-back Railroad, and on the W. side passes just N. of the Slope Colliery of the Diamond or Gin Vein. It crosses Zachariah's Run through the deep ravine which separates the two

synclinals of coal, and, traversing the watershed between this valley and that of Ravensdale, where it lifts the Little Perpendicular Vein, so-called, it passes across Crow Hollow, and so on to Mill Creek, where it folds the Hancock Vein northward over upon itself, and supports the Big Diamond coal upon its S. dip.

In the district of Silver Creek this is a normal flexure, steep on its N. side. But it becomes an inverted or folded one as it advances Westward as far at least as Mill Creek. On Zachariah's Run and Ravensdale we see it connected with perpendicular N. dips, and at Mill Creek, as already intimated, it folds back the Hancock Coal far over upon itself.

The coals elevated to the water-level of the first valleys intersected by this axis are considerably lower in the series than those brought up by the neighbouring anticlinal F. They are the same, indeed, on Silver Creek as are lifted out by the axis E—in other words, the Lower Diamond Veins. And this is very nearly the relation of things on Zachariah's Run. From the structure visible on Mill Creek, as exemplified in our section, where we make the Orchard Coal identical with the Hancock and the Lower Diamond, this axis lifts very nearly the same Coal-measures, which are there elevated by the adjoining axis F, and not by the remote one E, which has nearly subsided.

Basin F G.—From the superior force of the anticlinal G compared with F, in their range from Silver Creek to Mill Creek, the basin embraced between these axes presents a feature the reverse of the trough E F, and the wider one D E. In the present instance, the synclinal line is much nearer the N. axis than the S. one; and as a consequence, the N. dips from the anticlinal G greatly preponderate over the S. ones connected with the axis F. Hence it is that on Silver Creek there are five nearly perpendicularly-dipping coal-beds on the S. side of this trough, opposed by only a single South-dipping bed, the uppermost of course, of these five, on the N. side; and such is very nearly the condition of things on Zachariah's Run. We have already intimated that on Mill Creek, where this is a folded synclinal, the Hancock or Big Diamond, which is an inverted seam, is that which is involved in the fold.

Anticlinal H—*that of Sillimanville and Mill Creek Furnace.*—This is an important anticlinal, extending the entire distance from Sillimanville to the East Norwegian, and even further and is interesting as being the axis which limits on the N. the greatly prolonged and remarkably folded synclinal belt of the Peach Mountain coal-vein. From its apparent origin, a little W. of Sillimanville to Silver Creek, the line of the axis is very slightly concave Southward; but from that stream W. it is remarkably straight. This anticlinal is first plainly recognised E. of Bushy Valley in Bennett's Upper Peach-Mountain Vein, where an air-hole has been pierced from the mine to the surface, immediately on the axis. It is the saddle of the hill immediately N. of the junction of Bushy with Casca William valleys, and the hill N. of the Old Valley Furnace on Silver Creek, the crest of which it follows over to Zachariah's Run, where the arch-like character of the flexure is well exhibited at the cutting of the Old Drift Road south of the Gin and Perpendicular veins, a conglomeritic sandstone there spanning the axis in a symmetrical saddle. It is equally well exhibited on Silver Creek; but the dense small vein of conglomerate there seen in it is higher than that of the axis on Zachariah's Run by several coal-beds. We meet with it on Ravensdale, in a bold hill S. of the mine there wrought in the folded synclinal of that valley. Maintaining its course in the same belt of hills, it ranges across Crow Hollow under similar features and relations to the steep strata immediately N. of it, passing through the watershed

which separates that valley from Mill Creek. From Crow Hollow to the East Norwegian it everywhere holds its station in the S. summit of the double-topped broad hill visible on both sides of Mill Creek, where it is the axis to which belong the steep N. dips of the so-called Perpendicular Vein, a little N. of Patterson's Furnace. This anticlinal is remarkable, throughout its whole course until we reach East Norwegian Valley, for the great steepness, even to perpendicular, of the dips on its N. side, and for the relative gentleness of the dips upon its S. Even to the E. of Bushy Valley, the quarter of its assumed place of origin, the N. side of the wave is almost perpendicular; and not till we reach East Norwegian, where it begins to subside, does it assume the gentler form of a symmetrical saddle. At M'Ginnes's Shaft and Boring, sunk abortively on this axis in the vain expectation of finding the large Mammoth White-Ash coal of the Mine Hill approaching the surface within an accessible distance, the N. and S. dips are both about 48° or 50°. In this closely-compressed character of the flexure towards its E. end, and its subsidence W., we find it to agree with all the anticlinals to the N. of it, where they are traced to their terminations; and we are forcibly impressed with the conviction that they all owe the feature to one condition attending their formation—viz., to the remarkable thrusting forward to the N. of the part of the general coal-basin to the E. of Middleport, or what is an equivalent view, to the closer compression in that quarter of the general synclinal trough of the coal-field from the intrusion from the E. of two large anticlinal waves from the country outside of the valley. The Section will give the names of the coals at this axis on Bushy, Casca William, Silver Creek, Zachariah's Run, Ravensdale, Mill Creek, &c.

Coals lifted by Axis H.—Adverting to the particular Coal-measures which are elevated successively along the line of this extensive anticlinal, we find that they are very nearly the same for the whole distance from Bushy Valley to that of East Norwegian. In general terms, the coals which it produces at the water-level of the valleys, which successively intersect it, are usually in position five or six seams under the Main Peach Mountain bed, or those that appertain to the middle Red-Ash group. It is true, they bear various local designations in the various valleys where they have been mined, but it is one of the fruits of the patient researches connected with this Survey, that we have made their general identity clear. The exact relationships of the coal-beds brought up by this anticlinal at its intersection by the different valleys will be readily gathered from a comparison of the cross sections of the basin, and of the table of synonyms of the different coal-seams.

Basin H F and H G.—From near the Schuylkill Valley almost to Silver Creek the basin lying N. of the axis H is limited by the axis F. The highest coal-beds embraced by it at the passage of Casca William Creek are the near equivalents of the Peach Mountain Seam—most probably those next above it, as our Section will show; but on Silver Creek, where the basin is narrowed, and these upper coals are lifted off by the introduction of the axis G, the highest strata preserved in it embrace coal-beds which are three or four in order underneath the Peach Mountain, or those about the horizon of the Adam Stahl Vein of Casca William and Bushy. We thus perceive that the trough immediately N. of the anticlinal H, from Silver Creek westward to the Norwegians, contains an essentially lower group of coals than the wider trough H F, stretching from Lick Run eastward; and as we advance to the Westward, we find the coals belonging to the trough to be a little lower in position on Mill Creek and East Norwegian than on Silver Creek and Zachariah's Run. They are there, in fact, the Diamond coals, which, in the

two last-named valleys, characterise, as we have seen, the second basin N. of this, or that of the anticlinals E and F. And thus, as we proceed still further along the synclinal of H and G, the upper coals are successively thrown out, until at last, on the West Branch and on Wolf Creek, only the Grey-Ash and upper White-Ash beds are preserved from denudation. This change of the Coal-measures along the line of the same trough is a necessary consequence, as already intimated, of the obliquity of the undulations to the general N. border of the coal-field.

From Bushy Valley to Lick Run, the synclinal line of the basin N. of the anticlinal H is, in virtue of the steepness of the N. side of that axis, much S. of the middle of the belt; but at Silver Creek, and thence Westward, the introduction in the middle of this belt of the separate anticlinal G alters the structure of things, and by the comparative feebleness of the flexure G, places the synclinal belonging to the N. dips of H on the N. side of the now contracted trough. This is its position as long as the axis H preponderates over G, but when, as on the W. of Mill Creek, the latter becomes the sharpest and highest, the synclinal between them, as a consequence, lies closest to the opposite or S. side, and this will represent a general law for the position of the synclinal lines to the anticlinals which enclose them. The anticlinal H, the influence of which we have been tracing, forms throughout its whole length the N. boundary of the well-maintained basin of the Tracey and Peach Mountain coals; and to the consideration of this basin, and of the axis which marks its S. limit—or, in other words, the Peach Mountain range, as it is sometimes called—I propose now to proceed.

Peach Mountain Synclinal Belt.—This belt, when first clearly discerned, is marked by a simple synclinal structure of remarkable persistency. This is first visible on the high ground W. of Sillimanville, between that place and Bushy Creek, where it presents the character of an open and shallow trough, lying immediately S. of the anticlinal which was wrought by an air-shaft on both the dips by Mr Bennett. This synclinal is intersected by the Bushy Creek and Casca William Railroad, a little above their junction, where the peculiar sandstone and conglomerate, forming the base of the Peach Mountain group, are seen well exposed in gentle N. and S. dips on the opposite sides of the basin. Traced towards the W., the basin becomes closer and deeper, and on Lick Run assumes the form of a steep synclinal or V, in which the measures are vertical on the S. side, and dip moderately towards the S. on the opposite side of the basin. Here a seam of coal has been mined by Mr Robinson within the trough, and on both dips of the synclinal.

The basin becomes more closely folded as it extends Westwardly; and on Silver Creek, a little above the Old Valley Furnace, is seen to have this structure in a very remarkable degree. Here the two sides of the trough are closely folded together; the pebbly sandstone forming the bottom of the Peach Mountain basin is thrown on the S. side into an inverted dip in correspondence with the general inversion of the measures for some distance S. of the basin, and thus both sides of the basin dip towards the S. in nearly parallel, but slightly diverging planes, at an angle of about 40°, as exposed a little W. of the furnace. The slates and shales which separate the chief coal-seam of the group from the underlying sandstone are similarly folded, and enclose between them this coal-seam, which is seen to be doubled upon itself, and, as might be expected, is greatly compressed and in a crushed and faulty condition. On the open high ground E. of this exposure on Silver Creek, the two limbs of the synclinal may be traced by two parallel lines of shafting which extend Eastward to the workings in Lick Run. The upper bed of the hill marks

the N. outcrop of the conglomerate sandstone at the bottom of the Peach Mountain group, which here dips towards the S.; and the S. margin of the basin is indicated by the perpendicular and inverted dips of the rocks which form the N. part of the anticlinal adjoining the basin on the S. These are well seen on the road leading from the Furnace to Lick Run, where it descends in a somewhat Northerly course into the valley of the latter. After passing towards the S. obliquely over the folded measures of the anticlinal in question, and across the axis-line itself, this road curves onward again towards the N., and as it descends to the valley of Lick Run discloses the rocks of the N. side of the adjoining anticlinals in nearly vertical dips. On Silver Creek the Peach Mountain coal is mined on the W. side of the valley by Capewell, Dovey, and Southall.

In these workings we find that the synclinal structure is accompanied by a dislocation or fault; the Northern or South-dipping limb of the synclinal is prolonged downwards below its intersection with the Southern limb, here called the Perpendicular Vein, giving to the two together a form somewhat like that of the letter **Y**. This may be conceived to have arisen from a fracture at the bottom of the **V**, accompanied by an upthrow of the S. side of the trough.

The zone of the N. dips is much narrower than that of the S. dips, a feature due, Eastward, to the nearly vertical stratification of the Sharp Mountain, and the abruptness of the anticlinal, together with its general depression as compared with the crest of Locust Mountain. Prolonged in the same general direction, and with the same structural features, the Peach Mountain basin may be traced across the watershed to Zachariah's Run, where a South-dipping and a perpendicular vein have been opened in it, forming the synclinal basin.

From Zachariah's Run the synclinal may be traced across the hills to Ravensdale and Crow Hollow, and thence to the E. side of Mill Creek, by an irregular but observable depression of the surface lying a little N. of the line of the anticlinal already mentioned. In the interval between Zachariah's Run and Ravensdale, the basin loses its folded structure, becomes wider, and towards the S. edge includes an anticlinal roll or subordinate axis within its limits. These are its features, as observed a little N. of Singley's, and in its course thence to the Ravensdale Hollow. Here sandstone and conglomerate, underlying the Peach Mountain coal, may be well seen a few hundred feet S.E. of Mr Dovey's dwelling, dipping always to the S., and again on the side of the railroad, a short distance towards the S., with the opposite or N. dip. Between Zachariah's Run and this, the Peach Mountain coal has been shafted on in many places, and at certain points has been partially mined.

The measures next below those of the Peach Mountain group—viz. the Tracey conglomerate and slate—show themselves on the E. side of Mill Creek in a synclinal form at the junction of the main road with a lateral road to Crow Hollow. On the W. side of the valley the basin extends along the depression through which the road from East Norwegian runs Eastward towards Mill Creek. Here may be seen the cropping of the Peach Mountain coal, both on its N. and S. dips, in a very narrow and shallow basin, the N. margin of which lies a little S. of the position of the Summit Tavern. The anticlinal detected within the basin between Zachariah's Run and Ravensdale is continued across Mill Creek, and in the locality now in view forms the ridge immediately S. of the depression in which the Peach Mountain coal occurs. The S. dips of this anticlinal are very gentle, giving to it the character of a mere undulation on the N. flank of the great anticlinal which adjoins it on the S., and which is but the prolongation

of that already spoken of as marking the S. boundary of the Peach Mountain basin, in its extension from Casca William towards the W.

In its prolongation Westward of this point, the Peach Mountain belt presents a more complex structure, having the character of a chain of troughs or synclinals in an oblique parallel arrangement, but in one general direction, and either partly or wholly separated from one another by interposed anticlinals.

PEACH MOUNTAIN ANTICLINALS.

Anticlinal I., *or Main Axis of Peach Mountain.*—S. of the folded trough of the Peach Mountain coal, at a distance varying from 400 to 600 feet, ranges the leading anticlinal axis, the first traces of which towards the E. we detect in the hill S.W. of Milford Tunnel. We recognise it next on both sides of Casca William Valley, a few hundred feet S. of the junction of this and the Bushy Valley. It is here a normal anticlinal, its S. dips near the axis being gentle, and the N. dips only moderately steep. We encounter the axis again on Silver Creek on the hill immediately S. of the old Valley Furnace, and in the valley next E. of this; but in this vicinity, and Westward the whole distance as far as Ravensdale, it has the structure of a folded anticlinal, or one inverting its Northern dips into Southern ones. From Ravensdale to East and West Norwegian, this axis is much more dilated, presenting on its N. flank but moderately steep, and sometimes even gentle, N. dips. Where the anticlinal is a flexure with inversion, and the Peach Mountain synclinal N. of it is necessarily of the same character, it is brought much nearer to this latter than where they are both of the normal or open form. We see them thus compressed and approximated on Silver Creek and Zachariah's Run. This axis, like others of its group before described, observes a very gently-inflected line of direction, concave Southward, especially in the region of Silver Creek and Zachariah's Run, where it is most closely folded.

The coal-beds lifted to the water-level of the country in the range of this anticlinal are for the most part the two or three immediately subjacent to the Peach Mountain bed—that is to say, the Big and Little Tracey coals, and the Little Peach Mountain seam next under the main one: the lowest of these three, the Big Tracey, is exposed in the axis on Casca William Creek. The next over it, the Little Tracey, has been there opened, but is locally designated the Clarkson Vein. The Chas. Potts Vein of that place is probably the Little Peach Mountain, and the Palmer the Peach Mountain Proper. On Silver Creek, the third coal beneath the Peach Mountain Vein, the Big Tracey of Mill Creek and East Norwegian, is lifted, and denuded into two outcrops at this anticlinal; and here the next above it, or the Little Tracey, is called the Chas. Pott Vein on the S. side of the axis; and equally erroneously, that which next overlies the equivalent of the Little Peach Mountain is here styled the Palmer Vein. The Peach Mountain, on this S. dip of its Silver Creek anticlinal, is in all probability the second, possibly the first, under the so-called Spohn Vein of the locality; unless, indeed, there is an interpolation of a thin bed, in which case the Spohn Vein and the Peach Mountain are the same coal-seam. This axis, rising gradually as it reaches Ravensdale and Mill Creek, brings to the surface apparently two or three coals lower than the Big Tracey seam, but, expanding and flattening in ranging further Westward, lifts in the East Norwegian Valley only the Big Tracey above the water-level.

Anticlinal I, *or Southern subordinate Saddle of Peach Mountain Axis.*—In speaking of the structure of the Peach Mountain belt of the Pottsville Basin, it has been stated that in some districts the main anticlinal is accompanied by one or more parallel subordinate saddles, or, what is nearly the same thing, that the whole anticlinal zone comprehends usually one long though not continuous axis, flanked by one or two shorter and still less continuous saddles. In the district before us we meet with one of these attendant smaller undulations, a little S. of the chief one, at a distance of usually from 400 to 600 feet. The first Eastern exhibition which we have detected of this saddle is in the watershed between Ravensdale and the brook next E. of it. It is seen near the road leading E. from Ravensdale, and a little S. of the junction of the Ravensdale and Crow Hollow streams; and we meet with it again in the hill dividing Mill Creek Valley from East Norwegian, where it forms, indeed, the main summit to the S. of the Peach Mountain basin. In its range W. from the latter valley, it is this axis which seems to constitute the true crest of the so-called Peach Mountain; the other anticlinal of the belt, or axis I, so much more important than it, to the E. of Mill Creek, becoming, in its more Western range, but the subordinate companion of this one, forming, indeed, but a roll, as it were, upon its N. flank.

On Mill Creek and the East Norwegian, the axis I lifts out the Big Tracey coal into a North and a South-dipping outcrop, and it is by virtue of the greater prominence of this anticlinal here, as compared with axis I, that the Big Tracey coal is spread out on the East Norwegian in an undulation so much flatter than is presented by any of the other coal-beds not thus involved in the double anticlinal.

CHAPTER V.

SOUTHERN COAL-FIELD BETWEEN TAMAQUA AND SILVER CREEK, ITS ANTICLINALS, BASINS, AND COLLIERIES.

Anticlinal Axis C.—Resuming our detailed description of the flexures of the coal-field at the Little Schuylkill, the first or most Southern anticlinal axis which we trace thence is that of the ridge bounding Tamaqua on the S. This axis is seen in the bank of the Wabash, at a short distance above the spot where the stream is crossed by the railroad, and from this point the anticlinal line appears to observe an almost straight course along the crest or brow of the ridge or plateau S. of the Wabash Valley for nearly a mile; thence it pursues the valley of the Wabash past Newkirk and Bucksville, W. of which latter place it occupies the S. brow of the ridge bounding the same valley on the N., till it passes S. of the Tuscarora Colliery (Tucker's Slope) at the intersection of the road and railroad; thence its course is to the mouth of the Palmer Tunnel.

Of the dips connected with this axis very little can be said in detail, or is indeed called for, because few or no openings of any sort have been made in it, except near the Little Schuylkill, and E. of Tuscarora. In the vicinity of Tamaqua it does not appear to be a much compressed or steep saddle. The gently-rounded outline of the edge of the plateau which it follows, and the dips visible near the axis, as indicated in our Section, go to establish the fact of the Eastward

flattening of this flexure. In accordance with this feature of its Eastward declension, we observe an absence of all external or topographical indications of it E. of the Little Schuylkill. If it reaches Sharp Mountain at all, it is only as a roll in its flank. Passing W. of Tamaqua, this axis increases in force, both its N. and S. dips growing much steeper than at Tamaqua, where they are as low as 30°. The very steep dips in the compressed synclinal fold which we see at the foot of Sharp Mountain at Tamaqua, are due less to the sharpness of the anticlinal than to the forward pressure and overtilting of the Sharp Mountain at the other or S. side of the basin.

Basin D.—Of the *coal-beds* embraced in the basin or trough between this anticlinal and Sharp Mountain, there is nothing of value to add to what has been already mentioned respecting those visible at the Little Schuylkill, and displayed in the Tamaqua Section. The highest must evidently belong to the lower Red-Ash coals; but it is manifest, from what we behold at the foot of the mountain, that those at least which are most involved in the squeeze at the synclinal axis are not likely to be in a very sound or suitable condition for mining. The beds arching the anticlinal are, from the absence of compression, and from their gentler dips, in a probably more unbroken state, but they have been insufficiently explored. At Tuscarora there are three saddles S. of this one, or between it and Sharp Mountain; but the description of them is deferred to a later section.

SECOND AND THIRD TAMAQUA ANTICLINALS AND RELATED BASINS.

Axis B.—The next axis of Tamaqua, that N. of the town, is visible on the E. side of the Little Schuylkill some 400 feet N. of the Mauch Chunk Road, and on the W. side in the hill or bluff immediately bounding the Wabash Railroad on the N. This it crosses further Westward to range along the crest or summit of the ridge running from Tamaqua to Newkirk. The abrupt arch of this anticlinal is seen at Newkirk, just E. of the Upper Coal-Breaker; but how far Westward it extends from this point is at present not ascertained, though it probably reaches Buckville. This is a sharp or closely-folded saddle, the dips on both sides of the axis being very steep, the Southward 70°, and the Northward even nearly 80°. The annexed cut (fig. 147) shows the overturned outcrops of the strata *both ways* from this axis.

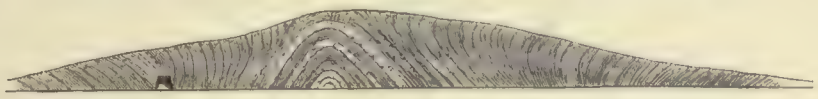


Fig. 147.—Anticlinal Axis B, near Newkirk, with overturned outcrop.

Mention has already been made of all that can be determined respecting the coals exposed in this anticlinal, or contained in the basin *C b* of the centre of Tamaqua south of it. Counting the coals visible at Newkirk, between the ascertained beds of the tunnel there and the valley of the Wabash in the synclinal on the S. of this axis, I am disposed to estimate the highest in the latter position as about the ninth or tenth above the first Red-Ash bed, or Grier Coal, so called, of the Slope Mine No. 1, near the mouth of the tunnel. Only the lower portion of these coals at Newkirk lies within the trough *b*, N. of this axis B; that is to say, between the second and third Tamaqua anticlinals. The condition of things is therefore about the same as at the Little Schuylkill. The synclinal line of *b* is a very short distance N. of B, and the flexure is *folded*, or the N. dips of *b* are steep, or even overturned below.

Axis B.—*The third* and Northernmost anticlinal of the Tamaqua district, that which I am disposed to consider as the Summit Hill axis, lies N. of the one just described only about 650 feet on the E. side of the Little Schuylkill. How far it is prolonged Westward it is impossible at present to determine, but a flexure met with at Newkirk, both in the surface strata and in the slope S. of the tunnel, is very probably this same axis somewhat enfeebled towards its termination. Their identity, however, is uncertain; but that there are two undulations at Newkirk is pretty evident; and this, the more Northern one, is very probably the undulation within the mine. If so, its position will take it, if it is prolonged, into Locust Mountain north of the Buckville Tunnel. The other, or Middle Tamaqua axis B, already traced N. of the main Mine Hill anticlinal C, is not extended apparently as far as the Buckville Tunnel, notwithstanding its steep dips between Tamaqua and Newkirk.

Of the coals in the trough *B b* between these two saddles nothing is to be added to what has been said of the vicinities of Tamaqua and Newkirk, for the presence of neither axis is yet established at Buckville.

Of the coals which are embraced between the N. axis and the flank of Locust Mountain, a general view is to be derived from the N. part of the Tamaqua Section. The notes and sections exhibiting the condition of things at the Newkirk and Buckville Tunnel will, with the Tamaqua details, give the reader all that was known in 1853 of the individual coal-beds, and the extent to which they were mined in the belt occupied by the two anticlinals.

BASIN *B*, REINHARDT'S RUN, NEWKIRK TUNNEL.

Newkirk Tunnel.—Coal E has been worked through to meet the great coal E of Tamaqua. The gangway from the tunnel has been carried E. at a level 90 feet higher than that from

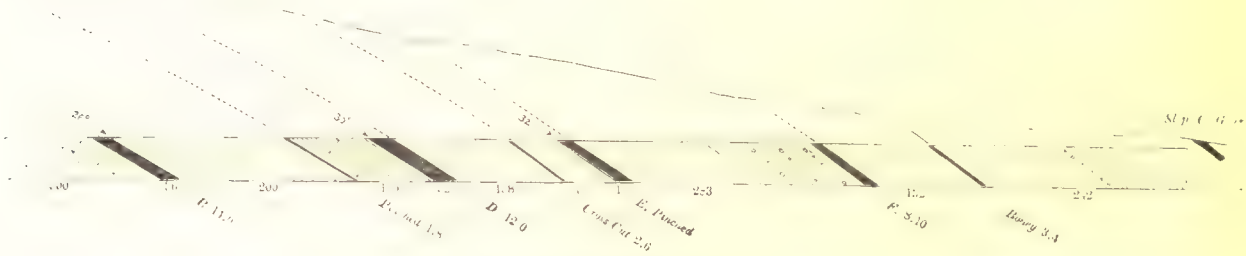


FIG. 148.—Section of Newkirk Tunnel.

Tamaqua, and has passed it by about 45 feet. A hole has been driven up from the latter into the former.

The bed first N. of D has been driven 400 yards E., and 400 yards W. of the tunnel. (This is the Pinched coal of our Section.)

Details of the coal-seam north of D (Coal C)—

Slate, ...	2½ to 4 feet.
Coal, ...	10 inches.
Slate, ...	15 inches.
Good coal—(This vein yields a strong Red Ash), . .	3 feet.

NEWARK TUNNEL COLLIERY NEAR TAMAQUA.

Film or parting,	1 inch.
Better coal,	5 feet.
Slate,	2 inches.
Coal,	4 feet.
Slaty coal,	2 feet.
Good coal—best,	3 feet.

Two hundred yards W. of the furnace the air-shaft on the vein is 287 yards above the gangway by the slope; the dip is 30°. On the same vein the air-shaft from the summit is 726 feet to the surface; the dip 28°. 200 yards E. of the tunnel the air-shaft on this bed is 283 yards to a gangway; dip 42°. The vein is faulty to the E., but good to the W. The faults are due E. and W. This is the most N. vein cut in the tunnel; it is still disputed whether it is B or C of Tamaqua.

R. Ratcliff and Co. have a slope (No. 3 Mine) on F vein below water-level. Bowman and Richardson have a slope on the large vein called Bowman's Vein (Slope No. 1) below water-level. A rock-fault occurs in F, driven W. under water-level by Ratcliff.

The cross-cut vein on the W. side of the tunnel is 60 feet from Coal D. It is composed of—

Rough coal—bird-eye,	1 foot.
Good coal,	2 feet.
Slate,	—

On account of the goodness of this coal, they are now taking from this thin vein about two-thirds of all they work. In the year 1853, about 500 or 600 tons per week were mined.

It is conjectured by some persons that Wiggan's coal is the Tamaqua bed C.

Vein F of Newkirk Tunnel has been connected with that of Tamaqua by a hole from the former down to the latter about 60 feet deep in the vein.

The coal E at the Newkirk Tunnel is reduced to only 1 foot or 15 inches. Going E. it increases rapidly. It has been worked E. about 800 yards. At half that distance it is about 12 or 15 feet thick; and at a distance of about 600 yards, at the E. end of the gangway, it is about 30 feet thick; it then thins again as we go forward, and at 800 yards is about 12 or 15 feet.

This vein varies so much in its subdivisions that no account can be given of its composition.

The F vein is at the tunnel 7 feet thick, and 100 yards E. from the tunnel it is 17 feet. 300 yards further it is about 22 feet, and this continues to the end of the East gangway about one mile above water-level. It had been worked at a distance of 150 feet below the upper gangway, or for 600 yards to the E.

It had also been worked to the W. 600 yards in a gangway above water-level, where a rock-fault comes in. The gangway below the water-level struck the same fault at 100 yards.

Dimensions of F vein on the E. side, where it is about 17 feet thick,—

Top slate,	—
White clod or clay—fire-clay,	2 feet.
Good glassy White-Ash coal—no slate,	7 „
Bony coal,	2 inches.
Very good coal—Pink Ash,	8 feet.
Shaly coal and dirt,	2 „

On the W. side, before coming to the fault on the upper lift, it begins at the tunnel at 11 feet thick, and is increased to 20 feet at about 600 yards. Then it is nipped close; but on the rise in the breast, about 30 yards above the gangway, it was 40 feet thick, the coal being rather faulty. The dip of coal F in the slope is about 33°, being steeper below and flatter above.

In Bowman and Richardson's Slope three veins are opened.

From the F vein S. to Bowman's Vein is 100 yards by a tunnel. This intersects 30 yards of slate on the top of F, and the rest is blue sandstone until we reach slate under Bowman's Coal.

From Bowman's Big Vein to the Little Vein the distance is 20 yards of slate. The dip of the Big Vein is 40°; that of the Little Vein is 45°.

A tunnel from the Little Vein to that next S. of it, called Big Diamond Vein, is about 100 yards long, the first half being slate and the rest sandstone.

There is sandstone above the Big Diamond Vein. The Bowman Big Vein is supposed by some to be the Grier. The distance of the Grier Vein from F at Tuscarora is 101 yards.

Bowman's Vein runs E. It is 100 yards to the rock-fault, which is not passed. The coal varies in this distance from 11 feet to upwards of 40.

When regularly worked it is about 9 feet thick. The coal at Bowman's is Pink Ash.

Fireclay, top clod white, ...	1 foot.
Good coal, but a little faulty, ...	4 feet.
Coal slate, ...	3 inches.
Good coal, ...	5 feet.

Bowman's Little Coal or Grey Ash is from 4 to 6 feet thick. It is generally a 4-feet vein, the bottom bench being 2½ feet; above this, 2 inches of slate, and then about 1½ feet of rough coal.

The Big Diamond Vein at Bowman's is about 9 feet thick, but in fault. It is not worked. This is pure Red-Ash coal.

About 20 yards S. of the outcrop of the Big Diamond Vein is another South-dipping coal, which has been proved, but not worked. It is called the Little Diamond Vein, and contains about 3 feet of good coal.

Another vein, about 3 feet thick, has been opened by a drift under the first screen. It is about 100 yards S. of the Little Diamond Coal.

South of the same seam, about 100 feet, is a small seam 2½ or 3 feet thick, dipping S.

There is a coal-drift 200 feet still further S., on a hill. It displays a bed about 7 feet thick.

A vein with a S. dip has been struck in a well at the Schoolhouse. It is small, and about 50 yards S. of the preceding. A short distance still further S. another coal has been struck, and still another bed, said to be thick, has been reached in a well on the S. side of the village near the main railroad.

Coals.—At Newkirk the *Grier Coal* is mined by a slope; it lies about 315 feet S. of the coal F, and is called Bowman's Big Vein. Its regular thickness is 9 feet. 100 yards W. of the tunnel it runs into a rock-fault. In this distance it varies from 9 to 40 feet in thickness; the dip at the slope is 40° S. It has a pink ash.

Coal A of Tamaqua.—The Newkirk Tunnel will ultimately reach this coal. Its outcrop is on the S. brow of the Locust Mountain.

Coal B.—This seam had not been reached at the date (1853) of our last examination of the district. Its outcrop is high on the slope of Locust Mountain. It has probably been cut in Newkirk Tunnel by this date.

Coal C.—The first vein North of D in the Newkirk Tunnel (C? of Tamaqua), was, at the date of our last observations, driven 400 yards E. and 400 yards W. of the tunnel. It is a strong Red-Ash coal. About 600 feet W. of the tunnel an air-shaft led 287 yards up the breast. The air-shaft from the tunnel is 242 yards up the breast, and 200 yards E. of the tunnel an air-shaft is 180 yards up the breast. The *dips* are severally 30°, 28°, and 42°. The coal-bed is faulty to the E., but good to the W. Its average *thickness* is about 17 feet. There is no doubt but that the first vein North of D in Newkirk Tunnel is C of Tamaqua. Ratcliff's line of air-holes on D, West of Tamaqua, are extended nearly opposite the end of Wiggan's Working, in this disputed vein East of Reinhardt's Run. The interval between the two ranges of outcrop is just that between C and D at Tamaqua. Vein C at Tamaqua is underlaid by about 4 feet of slate, below which there is a thin coal-seam not wrought. In the mine at Newkirk Tunnel the slate-bed is reduced in thickness, and becomes a slaty coal; and the underlying coal, here 3 feet, is wrought with the rest. This bench is a strong *pink-ash* coal. It is interesting to ascertain whether the bench below the slate at Tamaqua would yield a coal of the same kind.

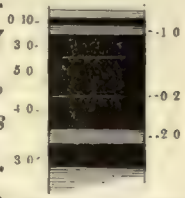


Fig. 149.—Coal (B?) C, Newkirk Tunnel.

Coal D.—Has been driven through from Tamaqua. Its dip is flatter than at Tamaqua, being 42°. The quality of the coal is the same.

Coal E.—This bed, in 1853, was worked through from Tamaqua to Newkirk Tunnel. In the tunnel it is only 12 or 13 inches thick; it has been mined E. from the tunnel about 800 yards. At 400 yards it is about 12 or 15 feet thick, at 600 yards, 30 feet, and then declines to 12 or 15 feet. The outcrop of this admirable seam of coal is traceable, by its air-shafts, along the flank of the Locust Mountain at a high level, the whole distance from the Little Schuylkill to the Newkirk Tunnel, and thence, indeed, to the tunnel at Buckville. Its position on the surface at Buckville is vertically over the intersection of Coal D by the tunnel.

Cross-cut Coal.—About 60 feet W. of the Newkirk Tunnel this coal consists of 2 feet of hard glassy coal, capped by one foot of bird-eye coal. It is largely wrought on account of its purity. It lies 45 feet S. of coal E.

Coal F.—The dimensions of this bed at Newkirk Tunnel are 7 feet. About 100 yards E. of the tunnel it measures 17 feet thick; 200 yards further E. it is 22 feet thick, and continues thus to the end of the gangway, or one mile from the tunnel. Its thickness on the W. side of the tunnel is 11 feet, and 600 yards further W. it is 20 feet; it is then nipped, and at the water-level it is 40 feet thick, and faulty. Its dip is 42° S.

It has been worked E. from Newkirk Tunnel one mile above water-level. In a gangway from the slope, 150 yards lower in level, it was worked E. 600 yards. From the tunnel-level it was mined 600 yards W. There a rock-fault appeared: lower down, or in the slope-level, the same fault was met. This has since been driven through. The Newkirk mines in this coal have been connected with those of Coal F of Tamaqua by a hole 60 feet deep, sunk from the end of the Newkirk level.

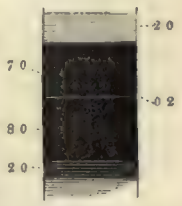


Fig. 150.—Coal F, (thickened), Newkirk Tunnel.

Bony Coal.—This coal has been cut in Newkirk Tunnel, where it is 3 or 4 feet thick.

Collieries.—The Reinhardt's Run property, owned by the Little Schuylkill Company, is

leased by four different parties, each of whom owns separate breakers. Beginning with the most Northern, these collieries are—1. Ratcliff; 2. Bowman; 3. Jones and Cole; and, 4. Wiggan and Son.

Newkirk Tunnel.—In 1853 this was driven somewhat more than 400 yards, cutting all the veins N. of the Grier Coal as far as B (see Section of the Tunnel). Most of the coals cut have gangways upon them, worked one mile E. as described. It is leased by Wiggan and Son.

Bowman's Slope.—This old slope, situated a short distance S.E. of the mouth of the tunnel, is sunk on the Grier Vein of Tuscarora, here called Bowman's Big Vein. This slope is 315 feet S. of coal F in the tunnel.

The *New Slope*, on coal F, is situated N.W. of the tunnel mouth about 450 feet; it is down 150 yards. The dip at the top is 42°, and at the bottom 38°. The gangways have been driven E. and W. from the foot of the slope.

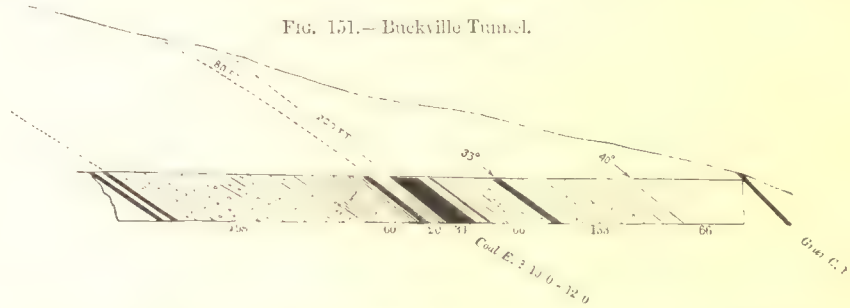
Coals in Basins B b and C b.—We may infer from the oblique direction of the basin *B b* from the Little Schuylkill to Reinhardt's Run, that towards the latter stream it must contain rather lower coal-beds than at the former; in other words, that one or two of the upper Red-Ash coals of Tamaqua may head out within this basin in going W. This tendency will, however, be somewhat counteracted near Reinhardt's Run by the dying-out of the anticlinal B.

The *Basin C b*, or that of Wabash Creek and Newkirk, will, on the other hand, be found, I think, to retain all the coals at Newkirk which it possesses at Tamaqua, for it rather expands in going W., until it opens into the main N. basin of Buckville, of which it is a branch.

COALS CONTAINED IN BASIN *C*, ON THAT OF THE BUCKVILLE AND PALMER TUNNELS.

Buckville.—The anticlinal axis B of Tamaqua, expiring Westward in the neighbourhood of Reinhardt's Run, and that next S. of it, B, not appearing to reach Buckville Tunnel, we are

Fig. 151.—Buckville Tunnel.



entitled to assume that from the latter locality, Westward to Big Creek, there prevails but one basin C, between the main axis of the valley and the top of Locust Mountain. The synclinal axis of this basin probably passes a little N. of the Buckville Breaker. Of course only the S. side of the whole basin, or that between the tunnel and the anticlinal C, contains the Red-Ash coals; all the N. half, or that occupying the slope of Locust Mountain to Coal E in the tunnel, being allotted to the White-Ash beds. The axis opposite Buckville must lift to the surface lower Red-Ash beds than it does at Tamaqua.

Coals.—*Coal F* (here also called the Grier Vein) is worked by a slope; its thickness is from 10 to 12 feet; the dip S. 40° to 45°.

Coal E.—This is worked E. from tunnel 600 yards, and the same distance W. Thickness of

coal about 18 feet: for its subdivisions, see the accompanying cut (fig. 152). In the level 300 yards E. of the tunnel they have driven N. across to the Cross-cut coal.

Coal D.—In the tunnel the next coal North of coal E is worked W. about 170 yards. Separated from the Cross-cut coal by 10 feet of slate, they are wrought together. The most Northern vein in the tunnel is double: the two coals are each 6 feet thick, with 20 feet of rock intervening in the tunnel, but 35 or 40 feet W. they come together, and the coal becomes dirt, and is valueless.

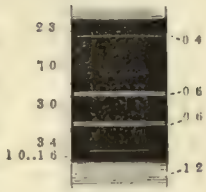


Fig. 152.—Coal E, Buckville.

Between the mouth of the tunnel and the breaker are the outcrops of four coals, all of them belonging to the lower Red-Ash group. These are the highest beds of this part of basin *C.*

Colliery leased by Jones and Cole.—There are two mining operations here, a *tunnel* and a *slope.*

The *slope* is in coal F, just W. of the mouth of the tunnel, and is down 318 feet; the dip is S. 40° to 45°. The thickness of the coal is 12 feet at the top of the slope, and from 10 to 11 at the bottom; between, the coal is very thick, but not so good.

Palmer Tunnel.—This tunnel, leased by Charles Silliman, has its mouth just N. of the anticlinal C, from whence it penetrates the basin Northward to the Big Vein, or Coal E of Tamaqua. It commences a little N. of the outcrop of the South Mortimer Coal, so called, and passes the synclinal axis of the basin between the next bed, the North Mortimer and the Grier Coal, these two being but the same bed with opposite dips. Cutting now only South-dipping measures, it crosses the Bony, the Palmer, and three other thinner beds, before it reaches the Big Coal, 97 yards N. of the Palmer. In this latter space it cuts 20 yards of slate, then a coal 2 feet thick, then sandstone 20 yards, a coal 4 feet thick, and at 22 yards further another coal 5½ feet thick; the remainder of the space is a hard pebbly rock.

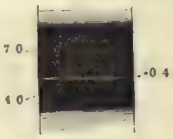


Fig. 153.—Tuscarora, or Palmer Coal of Tuscarora.

The Palmer Coal is from 12 to 14 feet thick, and is mined both E. and W. of the tunnel; in the latter direction a rock-fault, now passed, throws the bed about 60 feet N. of its true line of strike.

The Big Coal averages 20 feet in thickness; in the tunnel it dips 65° S., and E. of it, 45° S. West of the tunnel the dip is more constant. The breast of this coal is about 100 yards.

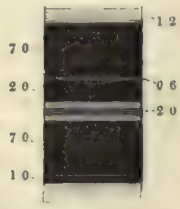


Fig. 154.—Coal E, Palmer Tunnel.

TUCKER'S SLOPE, BASIN C.

Coals.—*The Grier Coal.*—This is the coal of *Tucker's Slope*, half a mile E. of Tuscarora. Mr Kendrick, the mine captain, informed us that the bottom bench is Red Ash, 20 inches or 2 feet thick, while the top bench is Grey Ash, 3½ feet thick. It is good hard coal, somewhat streaky, though not so much so as the top bench, which is also a hard coal.

The coal called the Palmer Coal, cut by a tunnel driven N. from the Slope coal at Tucker's, and also cut in Palmer's Tunnel W. of Tuscarora, is no doubt the F coal of Tamaqua. In the Palmer Tunnel this coal is from 12 to 14 feet thick; it has lately been reached E. of Tuscarora.

Fig. 155.—Grier Coal, Tucker's Slope.

The *Tuscarora Coal* is supposed to be the same as the Palmer Coal. This coal lies in two

benches, the lowest being 4 feet thick, Red Ash, and a clear flinty hard coal; and the upper 7 feet thick, of streaky Grey-Ash coal.

Tucker's Slope is on the Grier Coal, and a little more than half a mile E. of Tuscarora. It is 150 yards to the bottom of the slope, which is 90 yards below water-level. A gangway has been driven 135 yards to the E., and 1200 to W. It encountered a remarkable dislocation at the end of the E. gangway (October 1853). From the bottom of the slope a tunnel was driven N., and cut the Palmer Coal (Coal F of Tamaqua). This has been wrought about 1400 yards W. of the tunnel, where it struck a rock-fault (1853). It was driven E. about 1400 yards, or within 25 yards of the line of the Little Schuylkill company. A slope has lately (1853) been put down by Reuben Jones 95 yards E. of the Tuscarora (Tucker's) E. line; this is on the Palmer Coal, or F coal of Buckville, and therefore of Tamaqua.

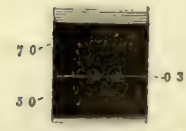


FIG. 156.—Palmer Coal, Tucker's Slope.

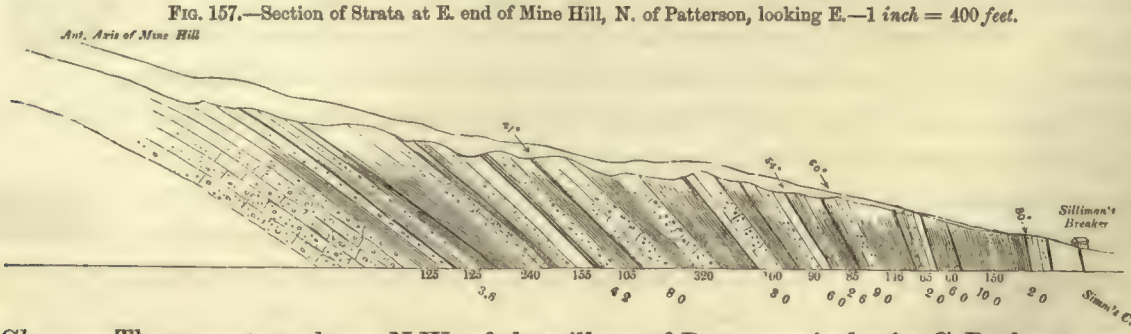
Basin C D, or that of Tuscarora.—This wide and regular sub-basin, the W. extension of basin *D* of Tamaqua, runs obliquely from Sharp Mountain to the S. foot of Mine Hill, and is thence prolonged between Mine Hill and the craggy ridge we have called South Mine Hill; its greatest depth is probably S. of Buckville, unless one or more subordinate flexures, *c* and *c c*, of Tuscarora, extend thus far E., and undulate its bed: it evidently contains the lower and middle groups of the Red-Ash series of coals; the two subordinate anticlinals which disturb it at Tuscarora, and the lesser basins which they make, have been already defined.

There are four or five mining operations in progress within this basin: Carter's Slope Mines, Pott's Slope Works on Big Creek; Silliman's Slope on Big Creek; Whitfield Tunnel Mines on Du Long Creek; and the Luther or Sinnickson Tunnel on Casca William Creek.

The Big Coal of the district coal E of Tamaqua enters the basin probably W. of Swift Creek, for in the Palmer Tunnel it outcrops many hundred yards N. of the Mine Hill anticlinal C, while at Potts' Slope, on the East Branch of Big Creek north of Brockville, its place is several hundred feet S. of that axis. On Main Big Creek its outcrop at the S.E. foot of Mine Hill, at Silliman's Slope, is about midway between the anticlinals C and D; thence it runs S.W., with one or two hitches in its course, to the upper Whitfield Tunnel, where its place is but a few hundred feet N. of axis D. The Bushy Tunnel does, or did not, reach it, but it is cut by the Luther Tunnel N. of Sinnickson's Slope; and it is traceable for a great distance, indeed, along the S. slope of Mine Hill, from its E. end to the valley of Silver Creek, where the basin becomes almost extinguished.

For the positions, distances asunder, and thicknesses of the other coals within this basin, the reader is referred to the engraved Sections representing some of the localities mentioned.

FIG. 157.—Section of Strata at E. end of Mine Hill, N. of Patterson, looking E.—1 *inch* = 400 *feet*.



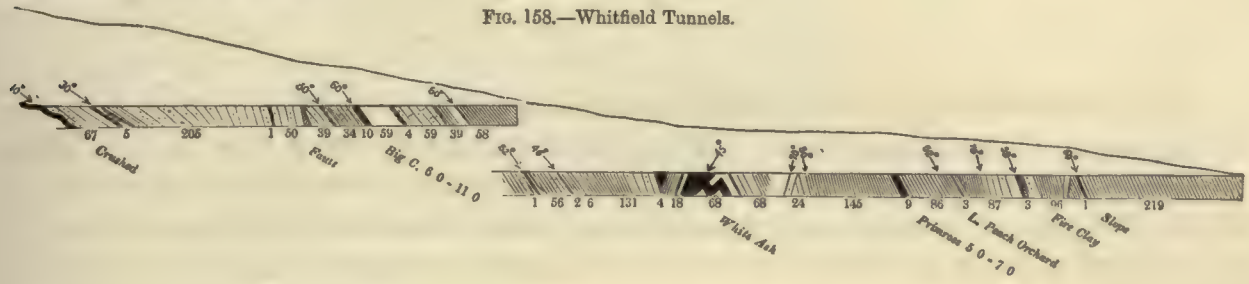
Slopes.—There are two slopes N.W. of the village of Patterson in basin *C D*, the one worked by Silliman and Meyer, the other by G. Potts; they are both working the same coal (the Big

Coal). George Potts' mine was (1853) some 20 or 30 yards below Meyer's working; the coal was not so sound as at Meyer's. He had driven both E. and W., and found his coal faulty.

Silliman and Meyer's Slope is 300 yards W. of Potts'. They have driven about 400 yards W., but not as yet to the E.

Whitfield Tunnels, De Long Tract.—The Big Coal was cut in Whitfield's Upper Tunnel; its average thickness there was 8 feet, sometimes it was 11 feet, and often 6 feet thick. There were three benches of slate between the top and middle bench; the top was sometimes rough, but the bottom always pure. In these features the two veins resembled that at Big Creek. The length of gangway E. was 400 yards, and W. 1000 yards; it was found faulty and large, being from 12 to 20 feet thick.

FIG. 158.—Whitfield Tunnels.



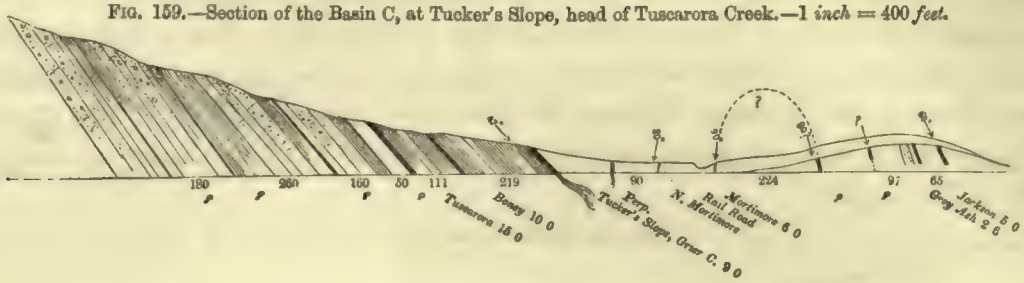
OF THE FLEXURES ANTICLINAL AND SYNCLINAL IN THE VICINITY OF TUSCARORA, AND THE COALS THERE DEVELOPED.

Axis C, *near Tuscarora.*—It has been already intimated that the southern Tamaqua and East Mine Hill axis, passing S. of Tucker's Slope, and of the mouth of Palmer Tunnel, ranges N. of the village of Tuscarora. Its N. dips are visible at the head of the cross street or road ascending towards the mountain, just at its bend Westward; N. of which a depression in the surface marks the basin at the foot of the mountain. The position of the anticlinal is on the next bench or terrace S. The anticlinal is cut by Swift Creek, in the gorge where this stream passes through the spur prolonged from Mine Hill. The N. dip at Tuscarora is not steep, perhaps from 35° to 40°, but such seems not to be the character of this side of the axis, except at this place and at Tamaqua; for near the intersection of the railroad and carriage-road below Tucker's Slope, the axis S. of the folded synclinal of the Slope Mine on the Grier Vein is compressed with excessively steep dips, those of the N. side being vertical, and those of the S. side 80° S.; and again at the mouth of the Palmer Tunnel, the dip of the N. flank of the saddle is perpendicular, or even a little inverted, the S. dip being here from 50° to 60°. At Swift Creek likewise the axis is thus equally compressed, even its South-dipping beds being as steep as 60°. This is not its configuration, however, where it passes Big Creek, and lifts the broad and swelling crest of Mine Hill. The more massive lower White-Ash Coal-measures, and the main egg-sized conglomerate beneath them, there rise in an ample and slowly-curving arch—only the remote abutments of which, far out from the axis, display a high inclination in the rocks.

Tracing the coals which are elevated in succession to the surface by this anticlinal from the Little Schuylkill to Mine Hill, we have an interesting and instructive illustration of the progressive emergence of the whole series from those of a relatively high horizon to those resting on the conglomerate. Thus, at the Little Schuylkill, this axis brings up, as we have seen, the

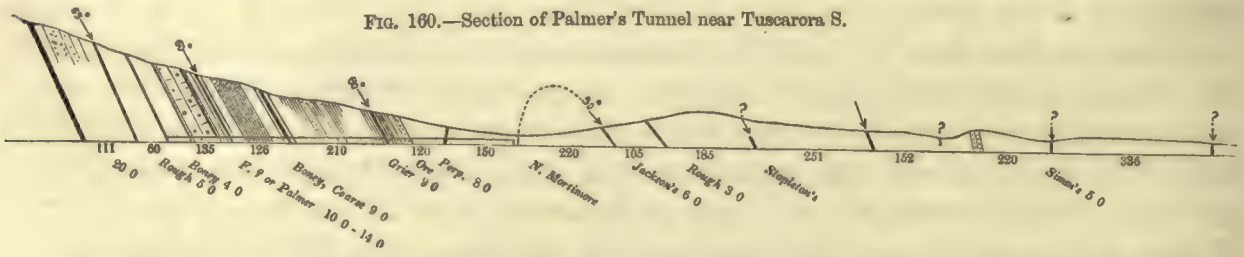
lower Red-Ash coals ; while opposite Tucker's Slope it exposes, as our Section there shows, the lowest of the Grey-Ash group, known here locally as the Mortimer Coal, the equivalent of the Tuscarora or Palmer bed—the same, in all probability, with the Coal F of Tamaqua, there the next in order above the true White-Ash group.

FIG. 159.—Section of the Basin C, at Tucker's Slope, head of Tuscarora Creek.—1 *inch* = 400 *feet*.



At a considerably higher level this Palmer or lower Grey-Ash coal almost emerges to the day at the mouth of the Palmer Tunnel (see Section of Tunnel), the Bony Vein, or next higher coal, being that which is there denuded at the axis. Advancing to Swift Creek, the Palmer or lowest Grey-Ash coal is found elevated high enough above a considerably higher water-level to be in its turn denuded, and to have its two outcrops separated to the two flanks of the anticlinal ridge. Finally, in the gorge by which Big Creek flows across the end of the main ridge of Mine Hill, the upper coarse beds of the great Seral conglomerate, at the base of all the Coal-measures, are elevated above the stream a height of more than 100 feet, but above the water-level at Tamaqua a height of several hundred feet. Adding the difference of level between the axis at Big Creek and at the Little Schuylkill to the positive thickness of the coal strata lifted out to the surface between the latter and the former spots, we discover an actual rise of the axis-line of this anticlinal, in a little less than 6 miles, of at least 1200 feet. West of Big Creek the axis continues slowly to ascend, spreading, of course, the outcrops of coals on its two flanks wider and wider asunder.

FIG. 160.—Section of Palmer's Tunnel near Tuscarora S.

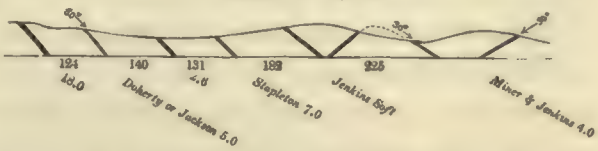


Basin C.—Of the basin between this anticlinal C and the S. side of Locust Mountain, there is nothing appropriate to add in this place to the information embodied in the Sections of the vicinity of Tuscarora. Its structure at Tucker's Slope, and in the Palmer Tunnel, are there correctly shown. In a theoretical point of view, the peculiarity in the flexure of the Grier Vein in Tucker's Mine is interesting, as displaying, by means of actual mining, a bulging upward of a concave into a convex fold of the roof and coal, a structure which, we are fain to believe, must exist on a large scale very abundantly in similar closely-compressed synclinal bendings, where sets of strata of unequal hardness and softness are, from the absence of crushing and sliding, unable to conform themselves, without this species of folding, to the reduced space into which they are forced.

Axis c *and* c c *near Tuscarora.*—South of the important anticlinal of Mine Hill above described, there occur in the vicinity of Tuscarora two saddles of inconsiderable length, and of subordinate influence.

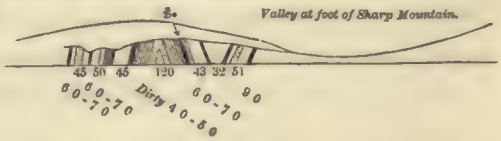
The more Northern of these issues from the ridge S. of the valley, embracing the watershed between the Wabash and the Schuylkill, and, crossing the latter, it enters the hill on which the village of Tuscarora is seated, passing a little N. of the main street, and S. of the Palmer Tunnel Coal-Breaker, W. of which meridian it is not at present traceable, through a deficiency of exposures. It would seem, however, not to prolong itself far. This axis has been proved by mining in the E. end of the hill supporting Tuscarora. It there appears as a saddle of very limited width, undulating a Red-Ash coal which is called the Jenkins Vein, in the middle of the wide basin formed by the South-dipping strata of the anticlinal C with the North-dipping beds of the saddle, c c, which passes through the hill to the S. of the village. This Jenkins Coal, thrown thus into two small subordinate basins, is apparently the second bed above the coal, better known at Tuscarora as the Jackson Vein, the precise relation of which to the Grier has never been determined.

Fig. 161.—Section of Red-Ash Coals E. of Tuscarora, looking E. 1 *inch* = 400 *feet.*



The more Southern of the two short Tuscarora saddles occupies the crest or rather the S. slope of the spur or hill immediately E. of the railroad, and next N. of the valley at the foot of Sharp Mountain. This little ridge extends not more than a fourth of a mile E., and the whole topography intimates the early cessation of the axis in that direction. Nor does it appear to possess a much greater prolongation Westward. We can trace it through the hill on which the Tuscarora Church stands, and may discern faint traces of it on the Palmer Tunnel branch railroad W. of this; but that is all: we lose every vestige of it further West.

Fig. 162.—Coals, E. end of Church Hill at Tuscarora.



There are four coals on the N. of this axis, all dipping at a very high or nearly perpendicular angle. They are all of them Red-Ash coals, and are therefore as high in the series, at the least, as the Stapleton and Jenkins beds, which lie next above the Jackson Coal. This axis, though seemingly so short, is a very closely compressed one, even its S. dip being as steep as 70°. It is evidently, however, not a broad saddle, for within 150 feet of it, on its S., there is a synclinal fold or trough bounded probably by the anticlinal which passes S. of the Tuscarora Church Hill, and not by the North-dipping strata of Sharp Mountain.

Anticlinal c c c *of Tuscarora, probably Axis* D, *or that of the S. Ridge of Mine Hill.*—There is an anticlinal to the S. of the Tuscarora Hill, not visible in the low grounds of the Schuylkill, but the N. dips of which form the bluff in which the hill S. of the church terminates, and are visible in the lower cuttings of the Palmer Tunnel railroad. This anticlinal has been detected in Chadwick's Mine S.W. of Tuscarora, his coal-bed saddling over the axis at a short distance up in the schutes above the water-level gangway. What coal this is which it elevates it is at present impossible to determine, but it evidently must hold a place rather low in the Red-Ash series.

From the position and direction of this axis, I am disposed to consider it the E. prolongation of the very important and interesting anticlinal of the S. ridge of Mine Hill, or that which has

been designated by the letter D. The paucity of exposures and of mining developments between the vicinity of Chadwick's Mine and the Whitfield Tunnel, where we first fall in with the indisputably recognisable axis D, is probably the sole difficulty in the way of our perceiving this continuity. In any view, we must regard this as the next leading axis S. of the anticlinal C which passes N. of Tuscarora, and therefore the whole belt between them, nearly two-thirds of a mile wide, may be best considered as one general synclinal tract embracing the lower Red-Ash and the Grey-Ash coals, and undulated centrally by usually about two parallel saddles—those, namely, of Tuscarora ; for it is quite probable that, between the Palmer Brook and Big Creek, other corrugations of the strata similar to those of Tuscarora, though not strictly prolongations of them, may set in and expire before reaching the last-named stream.

It must be obvious, from all that has been here disclosed of the structure of this abruptly-undulated belt of country, that some of its outcropping coal-beds must exist in a very crushed and faulty condition—and this is what experience would seem to indicate ; yet other seams of a sounder character have been profitably mined here, but on a moderately small scale. This synclinal range includes the South-dipping coals opened and partially mined on Big Creek and its Eastern Branch to the S. of the Mine Hill saddle. Like the small anticlinal flexures N. of it, its N. dips occupy but a narrow space, and it may therefore be viewed as but a roll checking for a few hundred feet the long succession of S. dips prevailing from the main axis C of Mine Hill to the basin at the foot of the Sharp Mountain.

The Short Saddle D.—This flexure, which, by a little latitude, may be classed as one of the Tuscarora group, lies, by estimation, about 1000 feet to the S. of the preceding. It is that which bounds Chadwick's Tuscarora Basin on the S., and by its sharply-compressed fold inverts, or, at least, lifts to a perpendicular position, the two coal-beds and their embracing rocks visible just N. of Chadwick's small breaker. The place of the crossing of this saddle by the Pottsville carriage-road is detected in the vertically-dipping slates seen on the roadside, but W. of this intersection, and E. of Chadwick's Breaker, we have failed, from the obscurity of the ground, in all our efforts to follow it.

Carter's Slope.—This recently-established mine, a short distance N.E. of the village of Tuscarora, is in what is called the Jackson or Doherty bed. The coal dips 60° S. ; its thickness is about 8 feet, but only a 3-feet layer near the middle of it was good coal at the time of observation (1853). The bed was faulty in the first gangway leading off from the Slope 100 yards down ; a tunnel from the foot of the Slope 75 yards S., cuts the Stapleton Coal, but finds it faulty, and from 9 to 11 feet thick.

(For a view of the improved Coal-Breaker and Slope-house at this colliery, see the sketch given in one of the Plates.)

CASCA WILLIAM.

Axis of Sinnickson's Slope, or Anticlinal D.—Tracing the lower White-Ash coals from Silver Creek eastward to Casca William, the outcrop of the big Egg-conglomerate which underlies the lower White-Ash coals is found passing more and more N., or behind the flank of the valley, until it takes its place far enough N. of the Big Coal of Casca William Tunnel to prove it to be the Mammoth Coal. The same view was confirmed by retracing the ground, for the conglomerates N. of the Mammoth Coal, on the N. side of the valley, were seen, one after another, passing down

with a sensible degree of Southing in going Westward, as if turning to basin. I satisfied myself that the axis N. of Chadwick's is that of Sinnickson's Slope. The arch is visible at the head of the hollow E. of Silver Creek Valley. Chadwick's Coal rises flattening upon the conglomerate, and Guiterman's Coal also flattens towards its outcrop under the same rock. I next traced the same anticlinal Westward from Silver Creek. It evidently holds its cover through the high flat summit of the ridge, and the upper Egg-conglomerate is seen in its S. dip all the way to the head of Windy Hollow, and past the head of Zachariah's Run, a little E. of which meridian the axis may be detected in more than one place in the rocks between this S. outcrop of the conglomerate and a ridge to the Westward answering to that at the head of Silver Hollow. This latter runs into, or nearly into, the bold flank of Mine Hill N. of Johns Coal. The deep cove behind the upper and lower White-Ash large coals evidently contains this anticlinal, for it is directly in its line. This hollow is indeed an excavation in the N. dip of the arch, seen in both dips at Johns dirt-heap, and also in the synclinal N. of it. The summit of the arch formed by the upper Egg-conglomerate is well seen in sundry places N. of the road on the ridge leading towards the reservoir. All the features of the topography and all the courses of the axes and of the outcrops confirm me in my view, that the Johns Coal is inferior in position to the Milne's or Mammoth Coal of Mill Creek. The lower large coal (Johns) is said to rise to the surface, or near enough to outcrop in the middle of the arch a quarter of a mile E. of the breaker, where the lower small coal and attendant rocks evidently reach the surface a little more to the W.

Coals in Basin D F, on Casca William Creek, in ascending order :—

1. *Big Vein* is the same as the Big North Vein of Silver Creek, as is proved by a line of air-shafts sloped upon it ; dip 61° S. Its average thickness is about 18 feet ; the gangway on its lower level has been driven 1000 yards to the W. ; it is sometimes called the *Raven* bed.

2. *Black Heath* (S. of Tucker's Silver Creek).—In the tunnel 28 yards S. from the Big Vein. The length of gangway is about 500 yards. Between Black Heath and Big Coal is a pebbly rock ; this is a Grey-Ash coal, 10 feet thick, with dip 60° S.

3. *Black Valley* is S. of the Black Heath 14 yards ; it is 7 feet thick ; it dips S. 55° ; its ash is grey, verging on red. The gangway is driven about 675 yards to the Westward.

4. *Brayler* Coal, 2 feet thick ; Red Ash ; S. of No. 3, 112 feet ; it dips 50°. Its gangway runs about 130 yards.

5. *Wright's* Coal is 8½ feet thick ; Red Ash ; very good coal ; 111 feet S. of No. 4 ; dip 45°. It has no gangways ; four shafts.

6. *Pasco* Coal is 8 feet thick ; dip 30° S. ; it is 400 feet S. of No. 5. No drift.

7. *Lyon's* Coal has 5 feet of good Red-Ash coal ; it is 63 feet S. of No. 6, and the 3d under the Luther.

8. (*Coal not named*), No. 3 of tunnel ; is 7 feet thick ; it has 4 feet of good Red-Ash coal ; it is 87 feet S. of No. 7. The gangway extends about 250 yards.

9. *Diamond* Coal, No. 2 of tunnel ; average 4 feet ; not extensively proved here ; the North Diamond of Neill on Silver Creek. It lies 48 feet S. of No. 8.

10. *Luther or South Diamond—the Red-Ash Slope Coal.*—Its average thickness is 5 feet ; its dip in the slope is 50°, but it is flatter on the same level further W. It has a gangway worked Eastward on its S. dip below water-level to the Hubley Tract. They have worked it up to the line of Bushy Tract.

In the N. tunnel there is a leader, 15 feet N. of the Big Vein, measuring from 1 foot to 18 inches in thickness. The Skidmore Coal is 47 feet N. of the Big Coal.

Basin D F, from Sharp Mountain to Silver Creek, or Patterson Basin.—This basin, running

off Westward obliquely from the N. flank of Sharp Mountain, is throughout its length to Silver Creek, and indeed beyond it, undulated by at least one subordinate anticlinal flexure: thus the axis D disturbs it in the neighbourhood of the Schuylkill and Swift Creek, and the longer anticlinal E divides it into a wide and a narrow trough between Casca William and Silver Creek. The Big White-Ash coal just reaches the surface to turn abruptly down again on its North-bounding anticlinal at the Sinnickson Slope on Casca William; but this nowhere else appears along its N. border, even the lowest of its South-dipping beds belonging to the Grey and Red-Ash groups. On the S. side of the basin those dipping N. from its bounding anticlinal F are the Red-Ash coals just under the Peach Mountain Vein, but these belong only to the S. half of the trough, for at Casca William, and probably E., certainly E. of Brockville, these upper Red-Ash beds are lifted out—not to re-enter the ground again—by the anticlinal flexures D and D. The engraved Section of the Casca William Coals will make this more obvious.

The principal mining operations embraced within this belt are Beachem's Mines S. of Tuscarora; mines on the Schuylkill N.W. of Beachem's; the De Long Mines of Whitfield Lower Tunnel; the Upper Bushy Mines; and the Red-Ash and White-Ash collieries on Casca William.

COLLIERIES AND COALS—SHARP MOUNTAIN COLLIERY.

Beachem's Tunnels.—The length of the Western or *Lower* Tunnel is not positively known, but it is about 120 yards. It cuts four veins, one of which is faulty, and not wrought.

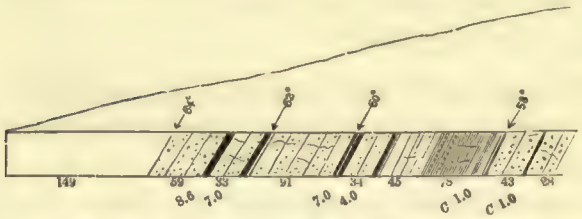


FIG. 163.—Beachem's Tunnel entering Sharp Mountain S.W. of Tuscarora, looking E.—1 *inch* = 200 *feet*.

1st vein from the mouth is 4 feet thick.
2d " " " 6 "
Sometimes 8 feet Pink-Ash coal—2 benches, 6 feet and 2 feet.
3d vein from the mouth is 6 feet thick—dirty.
4th " " " a thin leader.

From the second to the inner end of the tunnel is 80 yards, and it is about 40 yards from it to the mouth. The distance from the second to the third is about 25 yards. The tunnel ends in white Nut-conglomerate. The pitch of all these veins is about 60°.

The gangway on the Eight-feet coal of the Lower Tunnel has been driven W. 1200 yards; it was also driven 200 yards E. By shafting, this coal has been proved to continue through the Coal-hill estate, making the whole distance 1½ miles.

The Eastern or Upper Tunnel is rather more than 900 yards E. of the Lower, and the level is 40 feet higher. Its length is 600 feet, and it cuts five coals. (The numbers of the coals in the two tunnels express the same coals according to the idea of the proprietors.)

The first coal is about 100 yards from mouth of the tunnel; where struck, it is about 5½ feet thick. In the gangway it grew thicker, say 12 feet. It is mostly a dirty faulty coal.

The second vein—the rough vein—has the coal quite soft, and too rough to be saleable: its thickness is 2 feet.

The third vein is about 4 feet thick; it is hard, but too rough to be saleable.

Ten yards to fourth vein, 140 yards from the mouth of the tunnel; contains some good coal, 5 feet thick; it dips 60°; is in two benches, one 3½ feet, the other 15 to 18 inches—pink ash.

The gangway E. on the Five-feet coal (in the Upper Tunnel) is driven about 500 yards. The Upper Tunnel cuts two thin coals or leaders, the S. of which is 60 yards further than seam

No. 4, which is the one worked. It consists of 2 feet of hard bony coal, with about 7 feet of black slate underlying it.

BUSHY VALLEY.

Bushy Tract is bounded on the S. by the N. line of the Woodburn Tract. The compass-line along Bushy Railroad, from the head of the railroad on the axis-line at the Old Breaker Schute, is—

S. 30° E.—98 feet to Spring Coal overlaid by sandy slates; dip S. 50°; coal about 6 feet thick.
+ 83 feet to Ravine Coal, 3 feet thick; dip 50° S.
+ 68 feet to local Lewis Coal, 5½ feet, sometimes runs up to 12 feet, of good coal, Red Ash; dips from 40° to 50°.
+ 283 feet to dirt coal, 5 feet thick.
S. 1 8 E.—250 feet to 3-feet coal.
336 feet to a 2-feet coal—pretty good quality.
S. 4° E.—480 feet to Adam Stahl Coal.
Thence to Peach Mountain Coal.

From the axis at the brook crossing the railroad to the opposite schute of the Breaker is 1070 feet; the course is S. 4° E. The bearing of the chord below the Breaker is S. 12° E., distance 240 feet.

S. 38° W.—420 feet to the next turn of the railroad.
S. 22° W.—360 feet across the curve.
S. —180 feet to the Switch-back of Casca William Railroad. The N. dips of the quarry of sandstone and conglomerate are N. of Switch-back 180 feet. From this spot to Middleport the dips seem S.

There would seem to be an anticlinal in the tunnel of the Stahl Coal. This turn, which is the axis F, affects the Stahl. The dip in the gangway is about 35° S.; ascending, it becomes flat, and then descends in a counter-dip. The miners have sunk a perpendicular shaft on the top of the saddle, and found the rock horizontal, with shale and clay, and 2 or 3 feet of coal, fragmentary, and probably overlying the Stahl. The same thing occurred in an exploration some 50 yards further E. on the course of the bed. The vertical shaft is about 30 feet deep to coal a little S. of the crest of the saddle. On working a few feet N., the sandy slates were found level, and then rapidly turning down into N. dips. This is some 350 or 400 feet E. of the railroad. The drift-mouth of the Adam Stahl is to be placed at 480 feet from the small South-dipping vein.

On the W. side of the railroad the Stahl Coal is a sound good coal, from 4 to 7 feet in thickness. The axis shows itself as flattening, in rising, the breast in the gangway both to the E. and W. But the miners never drove over the anticlinal.

About 40 or 50 feet above the Stahl Coal is a coal about 3 feet thick near the outcrop. Its presence was proved on the W. side of the valley. 180 feet above this is another coal 4 feet thick, very clean and rich, but soft and shelly.

About 150 feet still higher is the Big Coal; it varies from 3 to 8 feet in thickness. In driving this, the dips were seen verging more and more to the E. as the gangway ran E. This Big Coal is the one opened at the crest of the hill on the road to Catawissa.

About 130 feet above the Big Coal comes the Slope Coal, which at the Slope dips about 20°, and steepens below. Its direction is nearly N.E., and its thickness is about 2 feet. It thickens and thins on successive swells.

The anticlinal would cross the railroad a little S. of the Breaker. The stack of the Breaker is about 350 feet from the railroad in a perpendicular line.

The anticlinal axes on Bushy Creek are—

1. That at head of Bushy Railroad.
2. Bennett's Northern axis a little N. of the gangway of the Adam Stahl Coal.
3. Bennett's Southern axis a little S. of Breaker, &c.
4. The axis which crosses the railroad near the fork.

Meyer's Tunnels on Bushy.—The lower tunnel cuts through greyish-ash coal. The head of this tunnel is near the anticlinal D. The last coal cut is the Spring Coal, the first is the Lewis Coal. The tunnel also cuts the local Lewis, Ravine, and Spring Coals.

The upper tunnel cuts two coals—1st, a soft coal 2 feet thick; the 2d, about 6 feet of worthless coal-dirt. The distance between them is about 30 feet, the dip about 75°.

Meyer says that the second vein on the N. of the axis of the Red-Ash mines, on Hubley Tract and Casca William, is the same as the second which he found on the N. side of the Bushy axis.

It is possible that one or more veins may occur between this axis and the mouth of the tunnel, but none have yet been seen besides the two which lie directly on the saddle.

Mr Meyer ran a drift on the second vein N. of the anticlinal about 300 feet; the dip was 45° N. The coal S. of this is much steeper than this, and steepens as it descends. The second vein appears to split, and the N. part of it runs off with a gentle dip, both dipping N. This lessening of the dip N. of the axis favours the idea of a second axis S. of the Upper Tunnel, as at Casca William. North of this second coal there is a blank (a swampy valley), where no dips appear, but where the second axis may come in.

The slope on Bushy at the Breaker dips N.E. 35°, and the gangway seems to turn to a more Easterly dip, indicating the W. end of the synclinal. The rock which crops out on the road from beneath the basin at the anticlinal axis on the S., looks very like the underlying rock of the Peach Mountain Seam.

The Luther or South Diamond Coal of Casca William is the second N. of the Lower Breaker, and first S. of the Ravine: it is worked through, and dips about 55° to 60°. It varies, and at Casca William is in steps. The seam is a clear good Red-Ash coal, 5 feet thick, and has a strong rocky 2-inch slate in it.

Basin F H, or that N. of the Peach Mountain Basin, from Sharp Mountain to Silver Creek.—This basin, commencing in the flank of Sharp Mountain S. of Brockville, and extending to Silver Creek at Quigley's Hollow, contains few or no extensive collieries: this circumstance is evidently due to its geological structure, which is that of a much-compressed obliquely descending or folded synclinal trough. Excepting the Peach Mountain basin S. of it, it is perhaps the most oblique or inverted basin in the coal-field. A glance at the Casca William Section will make this obvious to the reader: it shows three South-dipping folded troughs in the N. half of the basin (the Peach Mountain Basin,) the most S. being the most squeezed, and this one next. Being bounded both N. and S. by a folded anticlinal, it is obvious that its coal-seams, all of which belong to the readily yielding and soft upper Red-Ash Coal-measures, must be very generally in a crushed and bruised condition; and we cannot, therefore, be surprised that this, and the belt S. of it, have for so many years disappointed all efforts at the erection of permanently productive collieries. It embraces almost precisely the same coal-seams which are included in the Peach Mountain belt; only the Peach Mountain Vein itself, the uppermost in each basin, occupies a shallower and narrower trough. This identity of the central uppermost seam with the Peach Mountain bed, so clearly established by our Section, was long ago shrewdly conjectured by one or

two of the practical miners of the neighbourhood, who have laboured long but fruitlessly to make these Red-Ash Coal-measures productive.

Basin H I, or Peach Mountain Basin—Sharp Mountain South of Patterson.—This village is itself in basin *D F*, but at the railroad station there is a good exposure of slates dipping S. 20°, and in the hill on the S. flank of which these dips occur, there is evidently a synclinal axis lying S. of the railroad. At the E. end of the village there is a very steep N. dip in the slate. That there is a basin in this narrow-necked hill is proved by shaftings as well as underground mining. Indeed, the Palmer Vein gangway is worked round the end of it.

Milford Colliery, Peach Mountain Basin, Tunnel and Slope.—The slope is 132 yards down on the so-called Clarkson Coal, and 100 yards below the old water-level gangway; the breast is about 90 yards; the dip at the top of the slope is about 57°, at the bottom it is 42°. This coal-bed has been driven E. and W. from the bottom of the slope for more than 300 yards; the average thickness is 5 feet of good coal; there are occasional slate and bony partings; it varies from 2 to 6 feet, and has a covering of rotten slate from 1 to 3 feet thick. A tunnel is being driven (1853) from the bottom of the slope on the Clarkson Coal, S. to the Charles Pott Coal. The Clarkson is N. of the Charles Pott on the outcrop about 400 yards. The tunnel is 450 yards long. It starts at the Charles Pott Coal, and runs across the measures until it strikes the Palmer in S. dip. It then runs along the Palmer to the Eastward for 440 feet, and is then tunneled again. The actual tunnel-length is about 303 yards.

FIG. 164.—Milford Tunnel.

The Palmer Coal is worked on its N. and S. dips E. of the tunnel. The range of the N. dip of the Palmer Coal is in the N. side of the hill, that of the S. is in the S. side of the hill; the basin lies in the ravine, 270 yards S. of the tunnel's mouth. The breast of the South-dipping Palmer Coal is 64 yards, and the North-dipping is 58 yards to an upper level, thence the same distance to the outcrop. The dip of the North-dipping Palmer Coal is nearly vertical, but the dip of the N. part of the coal is S. about 15°—not enough to run the coal down the breast by gravity. The N. and S. gangways have been gradually turning, until now they come together, thus making the end of the basin.

The Palmer Coal contains about 2 feet of very solid coal.

The Charles Pott Coal is also about 2 feet in thickness.

The most Southern coal cut in the tunnel is about 52 yards S. of the North-dipping Palmer.

This coal is by some thought to be the Charles Pott Coal, but the Superintendent considers it identical with the leader cut N. of the South-dipping Palmer.

The dip of slaty sandstone at the foot of the breaker of Milford Tunnel S. is about 45°.

The coals worked by Billy Wall at Middleport—that is to say, the two N. coals—are the same as the N. dips of the Charles Pott and Palmer Coals, while the coal worked by O'Brian is still S. of the Milford Tunnel, and there is a drift on it in the brook S. of the end of the tunnel. The Superintendent says that he has shafted a coal on the second or N. spur of Sharp Mountain: he thinks the upper of this series are the same as those worked in Beachem's Tunnels.

The Clarkson Coal on the S. dip enters at water-level below the breaker, and has been worked E. about 1100, 1200, or probably 1300 yards, as far as the farmhouse S. of Patterson. There is a gangway in the old field E. of the farmhouse; here the outcrop passes N. of the house. Generally this coal has a gentle S. dip, but at the N. end of the slope it is about 55°. About 25 yards below the water-level in the slope there is a rock-fault, with a sudden upcast of 25 yards; it entirely cuts off the coal without even a leader: this is an unusual thing in this coal-basin. The Clarkson Coal is worked by Billy Wall at Middleport.

The *Charles Pott* Coal at Milford is entered by a drift just at the mouth of the tunnel; the dip is 55° S. The slates outside show a dip of 35° or 40° from hill-side pressure. It contains 2 feet of good hard coal, having rock at the top and slate at the bottom. It was worked nearly as far as the Clarkson, but in the tunnel it was mined only 15 yards each way. It was worked to the E. by Dr Steinberger, and at Middleport by Billy Wall.

It is believed that the Palmer Coal has both a N. and S. pitch on the Milford property S. of Milford Colliery.

Peach Mountain Basin traced from Bushy Valley westward.—Started from the quarry on the N. side of the anticlinal, near the junction of the Casca William and Bushy Valley Railroad, we may trace the axis on the S. side of the Peach Mountain synclinal over to Lick Run.

If followed by air-holes, the first S. dip next S. of the North-dipping rocks, brings us out S.E. of Thompson's house, at an exposure where the anticlinal is well seen. Following the strike with care, it leads into the road, to the right of which are shafts which run on to the Peach Mountain Coal of Lick Run. There therefore remains no doubt of the continuity of the Peach Mountain Basin from above the Casca William Fork to Lick Run. Mr Murray of Lick Run says that the Peach Mountain Coal had been wrought on both sides of the valley on both dips, the N. dip being nearly vertical, the S. comparatively gentle.

Middleport Synclinal Belt, or General Basin between the Anticlinals I *and* K.—After the general description which has been given of the broad and undulated trough enclosed between the Peach Mountain anticlinal I and the Gate Ridge and Silver Hill axis, it seems unnecessary, in the present imperfectly-opened state of this ground, to attempt a minute systematic description of it. Indeed, nearly all that is specifically known with regard to its coal-beds will be found assembled in the details now to be appended of the several mining localities which it embraces. If these are carefully perused in connection with the Sections, the reader will be in possession of nearly all the data accessible for a further tracing of its numerous valuable but much twisted coal-seams. It may be well, however, before entering upon these details, to call to mind the fact, that the whole of this belt, but especially its S. half, or that between the river and Sharp Mountain, is much contorted, and that it is not possible, with our present knowledge of its saddles, to subdivide it into continuous basins. The only regular basin which traverses the belt is that which extends through Middleport from Sharp Mountain to Silver Creek, near New Philadelphia, and the synclinal axis of which I have named *ff, fff:* this, it will be perceived, lies many hundred feet N. of the range of the great Norwegian synclinal of the N. foot of the Gate Ridge which passes through Cwmbola and Belmont. Adverting to the coal-seams embraced in the division of the belt E. of Silver Creek, they would appear to belong to the very uppermost group of the Red-Ash series, or that including the Peach Mountain and Spohn or Lewis beds. A reference to the Casca William, Silver Creek, and other sections, will make this immediately apparent,

and will show, moreover, that while the Peach Mountain Basin, so called, N. of axis I, contains but a very narrow trough of the seam of that name, this wider and less-folded belt possesses a much ampler and deeper basin not only of that coal, but of the locally-called Palmer Vein below it, and of the Spohn Vein above.

Middleport.—Coals of the Spurs E. and S. of the Town.—There is an anticlinal in the ravine at Lawrence and Brian's Old Colliery. There are here five coals, four of them mined, and all Red-Ash beds.

a. The first bed is worked out above water-level, and is not regular: it is sometimes 7, 8, or 12 feet in thickness, or even as high as 15 feet, and as low as 5 feet. It is called the Big Coal Vein. The gangways run 600 yards to the E.

b. There is another bed 60 or 70 yards N. of the Big Coal; it is sometimes called the Gate: it has about 4 feet of coal, generally regular. The dip is 45° N., but steeper near the W. end of the hill. It is clear Red Ash, and good coal. The gangway runs 700 or 800 yards E.

c. Bed 4 yards N. of *b*; has on it a gangway 100 yards to the E. It has Bone coal 4 feet in thickness, and in the shaft on the hill it has 4 feet of good coal and 3 feet of Bony coal. It dips steeply N.

d. Is 60 yards N. of *c*, contains 3 feet of coal; it has been worked through the hill. The dip is steep to the N.

e. Is 8 or 10 yards N. of *d*; its dip is steep to the N., and it has 6 feet of good coal, now in fault. It has been worked 300 yards E. These two will probably enter the Milford Spur, while the other three will range S. of the ridge, and enter S. of the farmhouse.

Shaftings and Tunnel S.E. of Middleport.—There is a steep S. dip on the railroad at Middleport. The coal is worked by Larry O'Brian. S.E. of Middleport is the "Big Gate," with steep dip N.

Dr Steinberger, the proprietor, thinks it the N. pitch of the bed which at Milford is worked on the S. dip. The coal and adjoining rocks are much alike.

Passing S. across a ravine, we come upon the Palmer Coal with quite a steep N. dip. Dr Steinberger has traced four beds around the E. end of a synclinal by his shafts. S. of this are N. dips for some distance, forming the N. side of the anticlinal lying S. of the above trough. There is a 10-feet coal N.W. of the tunnel, on the S. side of the ravine. The dip is very gentle to the S. The course of the tunnel is S.; the length is 420 feet; it cuts only one vein at its far end, which is 10 feet thick, and contains 6 feet of good coal; the dip is nearly vertical. N. 315 feet from the tunnel is the shaft of

Coal No. 1. The bearing of the tunnel is S. 19° E.; the dip of the coal is 36° S.; over it is Nut-conglomerate. There is a stream 40 feet from tunnel, and 280 feet to the foot of the ridge.

Coal No. 2. is 490 feet from the tunnel; its dip is 36° S.; it is 14 inches thick.

Coal No. 3. is 680 feet from the tunnel, the dip as above; it has 22 inches of coal. N. of this is the anticlinal. The distance from the tunnel to the first N. dip is 1190 feet.

Coal No. 4. There is a lower coal very thin on the S. side of the anticlinal; it has been followed round by shafts, and found out to be the fourth coal of those dipping N. on the other side of the axis.

General Beckel's Tunnel, S. of Middleport, is 140 yards long; it crosses the strata to the S. in the N. side of Sharp Mountain. This is what at present is called Dado's Tunnel; it was wrought by Neville.

Neville's Mine, S.E. of Middleport.—The coals have been shafted around an anticlinal axis next S.W. of the hill of Milford Tunnel. The basins N. and S. of Silver Hill and the intervening axes are proved by Dr Steinberger's shaftings. The next axis is proved by topography, and the dips

of the strata on its N. side. There are therefore three anticlinals S.W. of the Milford Tunnel Hill, combining to form the broad shoulder of the Sharp Mountain near Middleport. A line of outcrop extends from the Lower Beachem Tunnel, about 2 miles to the E. The turn of the S. basin is about 800 yards E. of Dado's Tunnel. Neville works a large coal in the New Tunnel, on the axis next N. of this basin of Dado, and also works it in the Dado Tunnel.

It has been supposed that the range of the shafting, &c. in the Eight-feet Coal of the Lower Tunnel would lie in a curve towards Middleport S. of Milford Tunnel Hill; but as that curve reaches round to Steinberger's Basin, the exact course is uncertain. Possibly an anticlinal comes out N. of the basin in question, which will make the curve not a blunt, but a somewhat more sharply-looped one.

Steinberger's Mines, half a mile S.W. of Middleport.—Near the valley of the railroad, Dr Steinberger is working the tunnel coal from 5 to 6 feet thick. He has driven his tunnel 80 yards (October 1853), and has cut three veins. The tunnel is driven S. The Gate Coal is drifted on N. of the mouth of the tunnel. Dr Steinberger is about putting a slope upon it. The first coal in the tunnel is 40 yards from its mouth; it measures 5 feet in thickness, but half of it is Bony. The second coal, 7 yards further on, is a good coal, from 3 to 4 feet thick. The remaining 33 yards, at the back of the tunnel, is not usually good; the coal is in fault, but when it is good, it is 5 or 6 feet thick. All these beds have a nearly vertical N. dip.

COALS AT MIDDLEPORT.

The *Clarkson* Seam at Middleport was opened and identified by Mr Thompson; its dip is S.; it contains 3 feet of coal and 3 feet of dirt, Bone Coal, and slate-top. It was shafted E. to Milford Colliery.

The *Charles Pott* Coal is 2½ feet thick, and faulty at Middleport. Havener worked it on its S. dip W. of Middleport, but the coal was not good.

The *Palmer* Bed varies from 20 inches to 2½ feet of good coal. All the S. dip was worked on the N.E. side of Middleport by Patrick Freeman on Hensinger's property.

The *Little Tracey* Coal has been shafted W. of Middleport; its dip is S.; its thickness 2½ feet; it has under it a coarse Nut-conglomerate.

The *Peach Mountain Vein* at Middleport is from 2½ to 4 feet thick, with a fine leafy roof and a slate bottom. This bottom-slate is 7 feet thick, and under it is a small rough bed, which looks like "baked bread:" it has no grain or lamination, but is like "twisted dough:" the coal is good, and of a rather pinkish Red Ash. The Peach Mountain Coal has the usual parting-slates, always recognisable, but here they are thin. The small underlying coal is well known at Pottsville. It has 1½ inches in thickness of a dull coal, like coarse cannel-coal, for its top ply, both at Middleport and Mill Creek. The Peach Mountain Coal is worked as far as Silver Creek.

The *Spohn* Coal at Middleport is worked by H. Uren; on its S. dip it was from 6 to 7 feet thick, and when faulty, declined to 2 or 3 feet. It had the same roof and slate as at Belmont (Five Points) and Centre Turnpike.

COLAHAN'S GATE VEIN COLLIERY.

Colahan and O'Hannan's.—There is an anticlinal axis well exposed in the bank on the side of the river, from which axis the centre of the railroad bridge is distant about 100 feet. S. of this

is another axis, and the basin between them has on its S. side perpendicular and inverted dips. The Perpendicular Coal, here worked by Colahan, is said by him to be the *Gate* Vein, but in the existing imperfect state of development of this much-undulated belt, from Silver Hill to the true Gate Ridge, it is premature to pronounce upon an identity so doubtful.

Coals—Big Gate Bed.—At this, the first place where it was discovered E. of Pottsville in the year 1845, the dip was perpendicular: it was worked entirely above water-level: it had 300 feet of breast: its gangway extended W. 600 yards, and its thickness was from 10 to 12 feet from slate to slate. The intermediate slate varies from 2 feet to 16 inches in thickness: both benches are worked, the N. being of an average thickness of 6 feet—the S. bench was from 2 to 2½ feet thick. The coal was not very solid.

In the N. dips, lying N. of the Gate Coal, two veins have been proved. The whole section shows—

1. 21 feet N. of the Gate Coal a small vein 3 feet thick. It was worked by Preston half a mile W. of this, where it was 5 feet thick. Here it was worked 200 yards, and became faulty. About 3 feet S. of it is a regular band of iron ore in slate.

2. 40 yards N. of this a faulty bed 3½ feet thick. It has been shafted at Preston's; it proved at Havener's to be good for nothing. Its crop is near Colahan's present Breaker. The S. slate is very reddish and shaly; the N. slate is a tough or bony rock.

3. 64 feet N. 51° W. from the end of the Breaker there are about 3 inches of a somewhat pebbly sandstone with perpendicular dip; N. of this the measures are slightly more inverted; at 150 feet it has a strong N. dip, and at 175 a dip of about 35° N., in a soft shaly rock. A thin seam occurs here, but its thickness was not proved; the dips were fast flattening. It was 250 feet from the Station.

4. In a direction N. 32½° W., measuring 193 feet to the centre of basin, the dips continue flat. A vein, not proved, is here supposed to be at 150 feet on this course.

5. N. 9° 10′ E. 215 feet brings us to a small 3-feet coal; the dip is S. about 45°.

At 315 feet is the centre of the *anticlinal.*

At 360 feet is a small North-dipping coal, and at 415 feet is the W. abutment of the railroad bridge.

Section South of the Big Gate Coal, course S. 56½° E.—At 100 feet, conglomeritic sandstone: 260 feet to *Little South Gate;* coal 5 feet thick, but variable; at one time it measured 25 feet, with perpendicular dip. The Bone Coal is on its N. side, and the black slate on its S. side. 25 feet further S. is the *main South Gate.* Its average thickness is 7 feet. The upper and lower slates are perpendicular, like the preceding.

120 feet across the strike is another *South Gate.* Across the strike, 180 feet S. from this, is what Mr O'Hannan thinks is the *Selkirk Coal:* it has been shafted, but is not worked; dip perpendicular; average thickness 7 feet; bony slate on N. side. Layer of slate about middle, one foot thick. About 100 feet across the measures from this is a 3-feet vein, faulty dip S. 50°: 169 feet further is a 2-feet coal called the Small Vein, dip perpendicular, 20 feet thick at outcrop; not faulty, but very variable; has been worked.

Axis further to the East.—About 200 feet S. of this axis is the *Black Mine Vein,* about 8 feet thick; 3 feet bottom bench; 4 inches undermining; 5 feet top bench; roof strong bony coal. From this Southward 75 feet is the *Tunnel Vein,* well shafted on; about 6 feet thick, two benches—much the same as the Black Mine. The Salem lies S. of this; it was shafted near Middleport by John M'Kachney of Tamaqua.

NEW PHILADELPHIA.

Preston's Colliery (Neville and A. Lawton's) opposite New Philadelphia.—In the year 1853, a slope was sunk some hundred feet S. of the breaker here. It is upon the Selkirk Coal, dipping S. 75°, now (Oct. 1853) sunk 60 yards. The coal varies from 8 to 14 feet thick, averaging 10 or 11 feet of good coal.

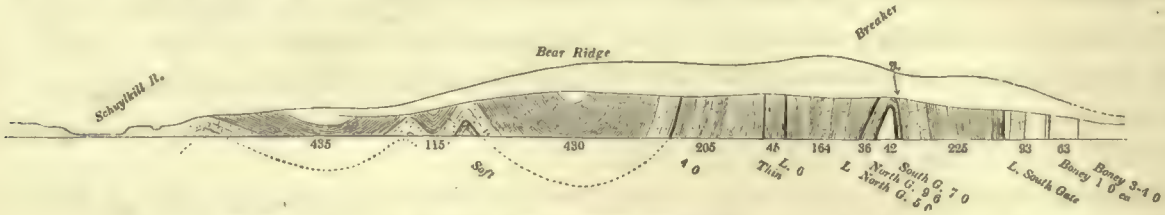


FIG. 165.—Section at Preston's (Neville's) Colliery off New Philadelphia, looking E.—400 feet = 1 inch.

Coals.—The first vein on which a gangway was driven on the W. of the creek contained about 2 feet of a coarse faulty coal; the dip was perpendicular: 22 yards to Northward of this are two coals separated by about 10 feet of slate; the S. one, with a gangway, contains 2 feet of poor coal; dip perpendicular: 31 yards N. to *Little South Gate*, has from 2½ to 3 feet of good coal; dips perpendicular 75 yards to *South Gate.* This has been worked four years on the E. and N. sides of the valley. On the E. side it was worked in 400 yards, when it ran into a partial fault. On the W. side there was a complete fault at 300 yards' distance; dip of the South Gate 85° S. The average thickness of the South Gate is 7 feet; the S. bench is 3 feet—divided by from 2 to 3 feet of slate. The N. bench has 4 feet of rather soft shelly coal; the S. bench is good coal, and outcrops on the surface of the hill; but the N. bench saddles 24 or 25 yards under the surface on the summit, and, turning down (according to Preston) by the side of the main or North Gate, makes from 12 to 14 feet of good pure coal with *no* bench.

Main or North Gate.—Has one solid bench of good coal, averaging from 9½ to 10 feet in thickness—in one place it is 19½ feet thick, and runs so for 8 or 10 yards; dip 85° N. The distance between the North and South Gate, at the gangways, is 14 yards on the E. side, and 21 yards on the W. side of the valley.

The measures on the E. and W. drifts are generally sandstone, with a good deal of iron ore, but for 15 yards S. of the Gate Coals we have soft slates.

About 12 yards N. of the North Gate we have the *Little North Gate.* It contains 4½ or 5 feet of good coal. The dip is 85° N., and parallel to the North Gate Coal. All these coals have from 60 to 70 yards breast. The North and Little North Gate mines were commenced in the spring of 1852.

John Preston's mine sends an average of 60 tons of coal daily to market.

There has within the past year (1852) been a slope sunk on the Selkirk Vein, S. of all the Gate veins: the dip is 75° S.

Lick Run.—The first coal of Casca William has been worked at Lick Run; N. of this is the Big Diamond, mined by Murray under the name of the Big Tracey. The working was probably on the S. side of the saddle; the N. dip is not seen. N. of this saddle is the comb or crest of conglomerate and sandstone, which has been traced from Casca William, and overlies the Adam Stahl. To trace this we ascended the comb of the hill, and followed it on the strike, having a series of shaftings on our right, or N. of the crest, and near it. These are on the coal seen directly beneath the conglomerate; N. of these again are Quigley's openings. The drift on Silver Creek

is on the coal. Following the crest, we struck the road on Silver Creek 300 feet N. of the Spring Coal. The anticlinal of the *Spring* evidently lifts the same conglomerate. This, I think, is the axis between the synclinal of the Peach Mountain or Small Coal, and that of the Tracey or Big Diamond, which is the large coal wrought by Murray on Lick Run.

Mr Murray worked the Big Tracey on the S. dips of a coal, and proved the synclinal axis by driving, near the angle, 4 feet across into the N. limb. The distance of the outcrop, at the surface of the two dips, is 40 yards. He says that the S. pitch is very variable. Towards the bottom the vein swelled out to some 20 feet thickness. The thickness of the seam is very changeable. It contains some very firm sound coal, and some mere dirt. He thinks that the Stahl Coal is S. of the conglomerate, or between it and the Big Tracey. Thompson and others, as above stated, place it near and beneath the conglomerate, or correspondingly to the 5-feet seam proved by Murray. From the range of the Tracey it is 525 paces to the Southern edge of the conglomerate.

Immediately under the conglomerate we saw *Murray's Drift*, and 100 feet further N. another drift, and 60 feet further a third. On the E. side are two drifts, 150 feet apart.

Coals ascending Lick Run—

1. *Palmer* Coal, 3 to 3¼ feet thick; good coal; worked up to the line of the Barrow and Evans Tract. Dip 35° S.

2. *Charles Pott* Coal is the same in dip and quality, and has been worked by the same person to about the same limits.

3. *Clarkson* Coal is not worked here, there being a long blank space.

4. *Peach Mountain* synclinal coal, with N. and S. dips. It is entered by a gangway on both sides of the ravine. The S. part, or perpendicular dip, is from 4 to 5 feet thick, and the N. side with S. pitch from 3 to 5 feet. The coal is a good quality of Red-Ash anthracite, but very faulty. The Peach Mountain must be the same as the Charles Pott.

5. *Big Diamond* (so called). The drift on this bed is higher up the creek. It was worked by B. and W. Murray. The dip on the top of the hill is 35° S. The thickness of this coal ranges from 4 to 7 feet; it sometimes swells to 20 feet. Between Nos. 4 and 5 are two other coals which have not been mined.

CHAPTER VI.

COAL-FIELD BETWEEN SILVER CREEK AND MILL CREEK, ANTICLINALS, BASINS, AND COLLIERIES.

Flexures on Silver Creek.—For a clear conception of the structure of the coal-field on Silver Creek, the reader should consult the elaborate Section in Plate I.

Anticlinal Axes.—1. The axis of Guiterman's Coal, axis D, at the head of the open valley, is the same as that of Johns and Pinkerton, Mill Creek, and that of the Casca William spur.

2. The axis of Neill's N. Diamond Coal, axis E, is but a minor wrinkle on Silver Creek. It is highest or sharpest E. of Neill's on Silver Creek, and flattens and seems to die to the Eastward, for his gangway turns its E. part at the distance of 600 yards, and the gangway above the water-level also turns round W.

3. The next is the axis first S. of Neill's Breaker, and on the W. side of Silver Creek, in a small spur just S. of the lower road to Eagle Hill, or at Capewell and Dovey's Cistern. It is axis F. of the Map and Sections.

4. The axis G is that of Capewell and Dovey's South-dipping slope, and is seen in Quigley's Hollow N. of his old drifts.

5. The axis H is seen just S. of the Spring below the mouth of Quigley's Hollow, and crosses Silver Creek in Fitzimmons Spur.

The thick beds of conglomerate and coarse sandstone in the Red-Ash Coal-measures, useful for recognition of the coal-beds, are :—

1. A conglomerate lying between the N. and S. Diamond veins. It is cut in Neill's Tunnel, and must therefore be cut in the Casca William Red-Ash Tunnel.

2. Another overlying the S. Diamond, of which it forms the roof. It is a coarse pebbly sandstone, weathers pinkish and yellowish, and bleaches grey.

3. A conglomeritic sandstone of the synclinal axis S. of Neill's Breaker. This third bed forms next S. an anticlinal, and probably immediately beyond it another synclinal axis.

The road which passes from Silver Creek over to Lick Run, leaving the former a few yards S. of the Valley Furnace, crosses the anticlinal which lies immediately S. of the Furnace. The dips on the E. side are perpendicular and inverted, and on the S. side steep and then gentle. It leads out into the Lick Run Valley, and to the end of the lower dirt-heap of the Lick Run Works. The argillaceous mealy sandstone, with conglomerate which underlies the folded synclinal, seen next N. of the furnace, is seen on both sides of this anticlinal. The line of this last would cross Lick Run near the old Breaker.

On revisiting this road, we found the strike of the mealy sandstone on the S. side of the axis to be N. 73° E.

This soft conglomeritic sandstone appears to be inferior to that which underlies the Peach Mountain Coal of Casca William, and even to the Clarkson Coal of that vicinity. In other words, we are here on the S. dips of the first anticlinal N. of Middleport, but a little lower in the series than anything there lifted to the water-level. This vein places the conglomerate supporting the Casca William Peach Mountain bed in the centre of the S. basin of Lick Run, but high on the knob E. of that valley.

COALS ON SILVER CREEK.

The lowest coal fully known on Silver Creek, in 1853, and displayed in a gangway driven E. about 300 yards, has an average thickness of 9 feet. It is so represented in the Silver Creek Section, where its position is also shown. It consists of two benches, the upper varying from 4 to 5 feet in thickness, and the lower one from 2½ to 3 feet, with a slaty parting between them. It is a good Grey-Ash coal, perfectly pure, the dip not too steep for mining.

The Big Coal—formerly Chadwick's, and now mined by Guiterman, Harper, and Company—is from 50 to 60 feet thick, the dividing-slate in some places being 10 feet thick, in others only half a foot. The more correct average thickness of this Big Coal is 45 feet, divided into benches, with partings of slate and soft mining. It is said to yield two-thirds merchantable coal. At the outcrop its dip is 40° S. Length of breast to outcrop 190 yards : the outcrop is on a well-marked bench of the mountain. The gangway was driven 900 yards E. The top keeps regular, while the bottom flattens in places when the coal becomes thicker. The capacity of this coal-mine is such, that the miners might easily load 60 cars per day, of 5 tons each.

SILVER CREEK COLLIERIES IN 1853.

Tucker's Big Coal.—The outcrop of this coal is about 45 yards above the water-level, making it 150 yards to the bottom of the slope at the time of observation: the thickness of the coal varies from 3 to 13 feet. In the slope the dip is steeply S.

Neill's Slope is on the *N. Diamond* of Casca William, or that next N. of the Casca William Slope. A tunnel under water-level goes from the N. Diamond to the S. Diamond and Neill mines, both coals to the E. and W. of the centre of Silver Creek Valley. This colliery estate runs $1\frac{1}{4}$ miles E. and W. The tunnel is 58 yards in length; that at Casca William is 55 yards. Both cut the same measures. Neill's cuts a conglomeritic sandstone 20 yards S. of the North Diamond Coal, and it averages almost 15 feet in thickness. Dip in the tunnel 42°, in the slope 38°.

Big, or North Diamond.—Seven feet of dirt. It is faulty, and contains no merchantable coal. It is identical with the Gin Vein in the new slope of Chadwick and Co., on S. dip of axis G. The South Diamond has 6 feet of a deep Red-Ash coal, perfectly pure, with not an inch of parting-slate. There are two other higher coals S. of the South Diamond, between it and the hard sandstone and conglomerate of the synclinal axis. Close above the South Diamond is a sandstone and pebbly rock of considerable thickness.

The Primrose Coal on Silver Creek has not been wrought; and now that the new railroad is placed so high, it will not be mined above water-level.

The coal on Lick Run, wrought by Murray, is the same as that worked at Silver Creek in the slope N. of the furnace. The coal seen in the anticlinal flexure directly S. of the furnace is evidently a seam *under* the folded one, or Peach Mountain Vein, of the synclinal of the furnace.

Capewell, Dovey, and Southall's Peach Mountain Slope, near the Valley Furnace, on the W. side of Silver Creek Valley, was not wrought in 1853.

The Peach Mountain Coal is said to be in strike with the seam which outcrops just below the furnace. The slope is 50 yards below the water-level. The pitch of the coal is steady at 45° S. A gangway was driven W. towards Eagle Hill (Zachariah's Run) 700 yards. There were 550 yards of good coal; other 150 yards were faulty. The coal has an average thickness of from 4 to 5 feet. There are three benches with undermining between them; the lower bench is 18 inches thick, of the best quality of coal; the top is of slate, poor and irregular; the bottom has a strong sandy slate,—thicknesses not proved. On going down, the slope encounters the *Perpendicular Vein*, causing confusion where it strikes it; beyond this it is regular. The slope continues about 10 or 15 yards. It is thought that the same coal is worked by Greene on Eagle Hill. The coal here called the Perpendicular Vein has a S. dip. In the Western Gangway they have tunneled across, and struck the Perpendicular Coal, and in a few feet the Slope Coal. The Perpendicular Coal varies in thickness, having from 2 to 5 feet of good sound coal; it is then nipped out Eastward, and the Slope Coal and Perpendicular Coal come together.

Twenty-five yards N. of the Peach Mountain is the *Little Tracey* Coal, from 3 to 4 feet thick; then comes the *Big Tracey*, which is 8 feet thick, N. of which is the Fitzimmon's Drift, leading about 150 yards to the W.

The bearing of Spohn Coal air-shaft from the opening on the E. side of the road is from 12° to 14° S. of W.; dip of coal about 45° S. A drift was recently opened below the furnace 500 feet, showing measures and coal dipping from 20° to 30° S., but faulty.

ANTICLINAL AXES TRACED.

Axis D.—This anticlinal was traced from the point of the spur at the Casca William White-Ash Slope, along the flexure of Guiterman's Big Coal at Silver Creek ; thence through the high valley S. of Mine Hill, N. of Ravensdale and Crow Hollow Hill, and N. of Milne's and Snyder's Upper and Lower Slope collieries, and in the arch of the conglomerate, which there supports the Skidmore Coal, and out to Mill Creek Valley at Johns' great dirt-heap.

Axis E.—This was traced from Casca William, at the flexure of the South Diamond Coal, through to Silver Creek, immediately N. of the slope on the Big Diamond (Neill's), and across Silver Creek, where it passes directly under the Public School-house, and thence over the watershed and down a ravine leading into the valley of Zachariah's Run at Windy Harbour. Declining Westward, it is the flexure which causes a great and sudden change in the trend of the Mammoth and overlying coal at the head of Crow Hollow. This axis appears on Mill Creek, passing under the swell of hills S. of Milne's and Snyder's Slopes, whence it crosses the valley to undulate the Big Vein and the Primrose Coal on the opposite side W. of St Clair.

Axis F.—This is the axis next S. of the Red-Ash Slope at Casca William, from whence we traced it through Lick Run directly N. of the massive bed of conglomerate, where it is exposed on the old railroad, above the most Northern drifts ; thence it was followed patiently to Silver Creek, through Quigley's Hollow and the hill W. of it. It appears on Silver Creek as the anticlinal in the centre of the double fold of conglomerate cut by Tucker's Railroad. Across Silver Creek it appears in the low spur next S. of that which sustains the School-house, and, rising and expanding Westward, it comes out on Zachariah's Run just N. of the folded synclinal vein of Windy Harbour. This is probably the same anticlinal which passes through Crow Hollow on its S. side, or on the N. side of the spur which separates this from Ravensdale. At Mill Creek it seems to be discernible in an anticlinal indicated a little N. of the line of Carey's Shaft, where it lifts the Primrose to its shallow position in the shaft, and throws out the Orchard Coal altogether from the ground N. of the hill.

Axis G.—This anticlinal passes Silver Creek immediately N. of the great bend of the new Switch-back Railroad, and on the W. side just N. of the Slope Colliery, on the Diamond or Gin Coal. It crosses Zachariah's Run through the steep ravine which separates the two synclinals of coal, and is seen in the N. end of the Ravensdale Tunnel as an inverted flexure, folding the Primrose back under itself. This inverted flexure crosses Crow Hollow, and then Mill Creek a little S. of what are called the Hancock Coals, which are folded by it into a close oblique synclinal.

Axis H.—This has been traced from near the mouth of Bushy Valley on Casca William, through the hill N. of the old furnace on Silver Creek, thence through the crest of this high ledge to Zachariah's Run, where its arch-like character is well exposed in the cutting on the drift-road S. of the Gin and Perpendicular Coals, where the axis itself is seen in an arch of conglomeritic sandstone. It appears in Ravensdale in a bold hill S. of the mine, wrought in the folded synclinal of that vicinity. Keeping the same belt of hills, it ranges across Crow Hollow under similar features, and through the watershed which separates that valley from Mill Creek. Holding its course through the Southern summit of the broad double-topped hill, it causes the steep N. dips of the so-called Perpendicular Coal of both Ravensdale and Mill Creek.

To the S. of this axis, throughout its whole length, is the well-maintained *Basin* of the *Tracey and Peach Mountain Coals.*

COAL-SEAMS ABOVE WATER-LEVEL IN THE SEVERAL BASINS BETWEEN SILVER CREEK AND MILL CREEK.

It will be useful to the reader, before presenting him with details of the collieries and local workings between Silver Creek and Mill Creek, to set before him a general sketch of the uppermost or accessible coals contained in the slender synclinal belts called basins embraced within this tract. In tracing in a previous chapter the anticlinal axes which traverse it, mention was made in each instance of the lowest coal-beds elevated by them; my present object is to show the highest seams resting above the synclinal beds, so that between the two we may be made aware of the whole immediately accessible contents of each basin. Beginning with the N. strip, and proceeding regularly Southward from basin to basin, we identify the coals outcropping within them as follows :—

Basin D E.—On Silver Creek, so feeble are the flexures D and E compared with axis C of Mine Hill, that neither of them produces more than a trivial roll of the superficial coals on the wide South-dipping slope of that broad anticlinal wave; and, as a consequence, all the coals of basin *D E* are seen dipping to the S. at angles of 45° or 50°, except those immediately involved in the narrow saddle E; namely the Little and North Diamond beds, which, for a very short distance, dip steeply N. Thus, then, the basin, or more properly the belt, *D E*, embraces all the lower White-Ash coals from the second below the Guiterman, all the upper White-Ash or Big Coal group, the Grey-Ash or Primrose Coals, and the two lower Diamond beds, in all thirteen, of which at least ten are workable.

On Zachariah's Run the chief coals opened in this belt are the Skidmore and the Big or Mammoth Coal, and the other White-Ash seams of the upper White-Ash group. The N. side of the basin—namely, the S. slope of South Mine Hill—contains the outcrops of the upper members of the lower White-Ash group, or Chadwick's and Guiterman's thick seams, but the S. side would seem not to embrace the Primrose or Orchard Grey-Ash beds. It would appear, in other words, that the synclinal line of the basin, or the keel of this one-sided boat, rises slowly Westward. This is further confirmed by the fact of our finding the Big or Mammoth Coal at the head of Crow Hollow, just under the surface, directly on the anticlinal axis E. Advancing to Mill Creek the belt is almost entirely a South-dipping one, but the inclinations are much more gentle than at Silver Creek and Zachariah's Run. It contains on Mill Creek about the same coals in its S. half as it does at Zachariah's Run, that is to say, the upper White-Ash group, with the addition of the Primrose; but, embracing a very feeble N. dip, it scarcely deserves the name of a basin at all.

Basin E F.—The narrowness and gentleness of the flexure F causes the basin N. of it to contain, like the belt *D E*, a very trivial amount of N. dips; indeed, it exhibits at the water-level no North-dipping coal. At Silver Creek it includes under a S. dip all the Diamond group, namely, the Little and North Diamond coals at Neill's Slope, and the South Diamond, and a 3-feet thick seam above this, besides a very thin band of coal still higher up. Probably at a deep level the undulation F is still more flat, and in this case the belt *E F* is but the N. side of the broader basin *E G*, which is the especial basin of the Diamond group. On Mill Creek it is a very flat wave, not a defined basin at all, containing the Primrose Coal nearly at the water-level.

Basin F G.—This belt on Silver Creek has a very narrow South-dipping side—indeed, it shows no South-dipping coal-bed, but its S. half includes the South Diamond Seam, and the coal next above it, under a very steep N. dip thrown off from axis G. These coals have been wrought in it on Zachariah's Run, and the whole Diamond group has been mined in this basin in Ravensdale, where a tunnel cuts the synclinal axis. At Mill Creek all the coals of the belt dip S., for the axis G is there an inverted one, and folds the Hancock bed into a compressed South-dipping V. It is the basin of Cary's Shaft.

Basin G H.—The belt *G H* at Silver Creek is, from the relative feebleness of the anticlinal H compared with G, the reverse in structure of the basin *F G*; that is to say, its N. dips are very narrow, while its S. ones, including the Diamond Group, occupy nearly the entire belt. These Diamond Coals have been mined at Zachariah's Run, where one of them, the North Diamond, goes under the name of the Gin Coal. The axis H becoming rather more prominent by the time it reaches Mill Creek; some of the South-dipping Diamond Group are there reversed by it at water-level into a very steep N. dip, the so-called Perpendicular Vein being one of them, probably the South Diamond.

The Peach Mountain Basin, embraced between the anticlinals H and I, contains on Silver Creek, as our Section shows, the Peach Mountain bed, Big and Little Tracey, and other coals of the Peach Mountain group, with moderate S. dips on the N. side from axis H, but steeply inverted ones between axis I and the synclinal fold; indeed the synclinal flexure is here dislocated, and the overturned, or S. half of the basin, has its softer strata in a very crushed condition. The same condition of things prevails on Zachariah's Run, where the V formed by the two outcrops of the Peach Mountain bed is nearly as narrow and obliquely South-dipping as on Silver Creek. (See Section.)

At the valley of Mill Creek, the synclinal axis having risen, and the flexure having expanded from the flattening-out of the previously compressed and inverted anticlinal I, the S. side of the basin exhibits only a moderately steep N. dip, while the N. side shows a broad belt of strata dipping at about 35° S. As already mentioned, the Peach Mountain Seam is, throughout all this extent of the basin, the uppermost of its coal-beds.

Basin I K, or complex Belt of Middleport and Norwegian, between Silver Creek and Mill Creek.—Overlooking for the present the imperfectly known subordinate flexures I and J and K K K K of the division of the belt between New Philadelphia and Mill Creek, I shall regard this tract as one wide and deep synclinal trough undulated on its sides, and having its synclinal axis in the conspicuous trough which extends from New Philadelphia through Cwmbola to the N. base of the Gate Ridge. It is impossible, in the present imperfect state of development of this obscure portion of the coal-field, to determine what coals occupy the very uppermost or central position within this deep basin. At Cwmbola and Belmont the Lewis Vein of those localities is the highest important seam; it basins almost immediately under the E. and W. reach of the Schuylkill. Going W., the basin widens by the gradual separation of the anticlinal J from the main compressed axis K, and the steep N. or perpendicular dips of the S. side, near Belmont, subside to 45° N., so that the small coals of the Sandrock series overlying the Lewis Coal, occupy a broad belt at the synclinal axis, twice as wide at least as the steeper trough they form at the river between Belmont and Cwmbola.

DETAILS OF THE SEVERAL COLLIERIES BETWEEN SILVER CREEK AND MILL CREEK.

Novelty Colliery ; Slope W. of New Philadelphia, mined by Connor and Roads).—The Spohn Coal dips from 30° to 35° S., is 4½ feet thick, with 9 feet of slate on the top, and a fine hard sand-rock below. Immediately on the top of 9 feet of the slate there is a 3-feet-thick coal, with a hard sandstone top. A thin leader occurs 20 yards N. of the Lewis Vein ; then comes what is locally called the Sandrock Vein.

About 20 yards N. of the Spohn Vein is a leader or thin coal from 12 to 18 inches thick, and 80 yards further N. is the Palmer Coal. The Palmer Coal occurs at Cwmbola, but *not* at Five Points. On the Spohn Coal there are drifts all the way to Five Points. The slope at Connor's and Roads' is in all probability in the *Spohn* Coal, and not, as some suppose, in the Sandrock. There is a slope on the Palmer Coal which has 3 feet of good coal all in one bench, and dips from 35° to 36° S. Below the coal lie 18 inches of loose dirty slate, then a yellowish-grey very argillaceous sandstone, about 6 feet thick, and regular. The top rock is a firm and smooth black slate, and has stood in the gangways without pillars for 300 or 400 yards.

The drifts on the Palmer Coal were 800 yards E. and 700 W.

The *Charles Pott* Coal is 38 yards N. of the Palmer Vein. It dips 38° S., and averages 2½ feet of good coal, but it is in many places poor. Its drifts were 400 and 500 yards E. and W.

The *Clarkson* Coal is about 100 yards N. of the Charles Pott bed ; the dips vary from 28° to 45°. Its average thickness is 5 feet ; it is much broken and dirty ; the drifts were 500 yards E. and 100 yards W. The Peach Mountain Coal of Valley Furnace lies 500 yards N. of the Spohn Vein.

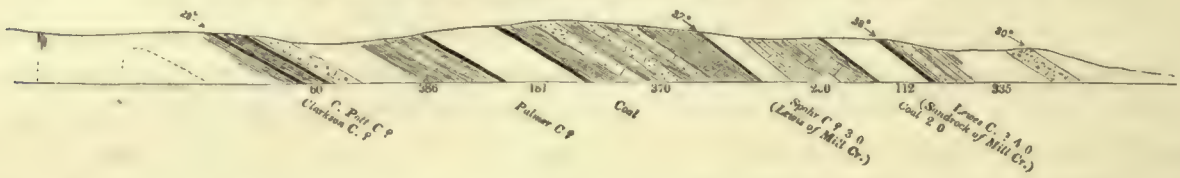
The *Slope* is down 140 yards : the coal averages 4½ feet ; it is good on the W. side for 800 yards, which is at the end of the gangway. On the E. side it is good for 400 or 500 yards, when a stone fault, running N.E., cuts off all the coal. The coal lies in two benches ; the bottom bench is about 2 feet thick, and is rather the best. The upper bench is 2½ feet thick. The benches are irregular, and sometimes the coal is all in one solid block. The Spohn Coal is very subject to jumps or sudden sharp small folds in the gangways. The coal will turn up for 10 feet perpendicularly, and then go down with the regular pitch.

CWMBOLA, HUBLEYVILLE.

Cwmbola Colliery, mined by W. Y. Agard and Company.—This slope is on the *Lewis* (the true *Sandrock* of Mill Creek) : the dip at the top is 38°, and at the bottom 23½° ; the coal contains 4 feet of coal in three benches. On the E. gangway are two benches of slate between the coals, but on the W. gangway there is but one. The W. gangway was driven 450 yards, and the E. 350 yards, but it is somewhat confused. The roof is of good Bony coal, the bottom is the same : the slope length is 225 yards ; it has four lifts and three gangways. From the bottom of the slope, about 55 yards towards the W., commences the tunnel, which is driven N. about 65 yards. At 37 yards it cuts a 22-inch coal, with mixture of coal, slate, &c. ; this is called by some the Yard Coal. The tunnel passes through sandstones, &c. The E. gangway curves rapidly to the N.

The slope on the Spohn (or true Clarkson) Coal is 102 feet down from the surface. The coal above water-level is worked out by drifts.

FIG. 166.—Section at Cwmbola from anticlinal J, looking E.—1 *inch* = 400 *feet*.



The *Sandrock* Coal, in ranging Eastward from Cwmbola, passes into the flats of the river. The Lewis Coal is caught in the hill at the road.

Synclinal Axis of Cwmbola.—At the E. end of the village is a good exposure of a synclinal axis along the bank of the river. On the S. side of the basin is a powdery exposed rock in the river. The dip is vertical, then N. nearly vertical; from this, going up the stream, it becomes from 60° to 70°. The strike of the vertical dips is N. 68° E., cutting the spur from Bare Ridge E. of the town. From these N. dips to the middle of the basin is 125 feet. The synclinal axis is 325 feet S. of the upper pier of the railroad bridge, opposite the engine-house.

Havener's (formerly), now Colahan's.—The shaft at Havener's, at 38 yards down, strikes upon a seam (the Blacksmith Coal) which rolls into a kind of saddle or egg-shaped turn. From this a cross-cut N. reaches the North Gate Coal. There are three nearly vertical coals S. of his shaft before we meet the regular South-dipping coals—the Black Mine and Tunnel Coal, &c. Colahan, making the above statement, adds that the Gate Coal cut in the tunnel, 22 yards N. of the foot of the shaft, which is thin, with a perpendicular N. dip, turns, in crossing the ravine, to a steep S. dip, and at the end of the gangway, 280 yards farther, it is regular and good, dipping a little S.

PINKERTON'S TUNNELS, BARE RIDGE (ABANDONED IN 1853).

Eastern or Upper Tunnel.—Length 115 yards. The coals all basin above the tunnel-level. The tunnel was driven 40 or 50 yards S. of where the veins ought to be, but for a synclinal axis. The S. dips were 35° at the entrance; the basin was about 70 yards in. The N. dips of the basin were 35°; they cut one little seam in the roof of the tunnel, 18 inches in thickness. The rocks were slaty sandstone.

Western or Lower Tunnel.—The dips are nearly vertical. At the mouth they are S., and then N. It was driven in 117 yards to North Gate and Havener's Big Coal: 15 yards in it struck a 4-feet coal; 4 or 5 feet of slate at the top and bottom. The North Gate Coal, at the end of 70 yards, is 4 feet thick, with good coal; 9 feet of slate.

Havener's Big Coal has from 5 to 7 feet of coal. Face of tunnel 60 or 70 yards. The rock is a hard coarse sandstone.

Christopher Rooney gives the following account of the Lower Tunnel: For about 15 yards the rock was soft and sandy, then a small leader 18 inches thick, 30 yards of fair ground, 30 yards of hard sandstone, 90 yards to the first 3½ or 4 feet of coal; 8 yards farther another 4-feet-thick coal; 10 yards more, a small coal of 18 inches or 2 feet. The dips are vertical throughout.

The line of strike from the mouth of the Lower Tunnel in an Easterly direction ranges over the flat S. of Cwmbola, and strikes a little N. of the crest of the spur which points out North-

ward from Bare Ridge, on the other side of which is Havener's. The hill opposite Cwmbola is cut out by denudation into a concave sweep.

Between Cwmbola and Havener's Breaker in the railroad cut, at the foot of the spur from Bare Ridge above spoken of, we find shales and slates; rocks evidently on the N. side of the synclinal of Cwmbola.

OLIVER'S COLLIERY, S. SIDE OF BARE RIDGE, (OWNED BY SHIPPEN AND WHITAKER).

The *Rabbit Hole* Coal is the first coal opened and worked. Across the strike from it to the tunnel coal is 170 feet. It is drifted on, and is 3½ feet thick.

The *Faust* Coal is known to exist here, but has not been worked.

The *Tunnel* Coal is the only one which has hitherto been much worked; it has been wrought at intervals for fifteen years, and has been driven as much as a mile to the Eastward; dip from 30° to 35° S. It was worked W. of the Breaker; its thickness was 5 feet; the bottom bench had from 2 to 3 feet of excellent coal, there was a thin slate parting and 2 feet of coal in the top bench; then from 6 to 8 inches of slate and Bony coal for the roof; the slope is sunk 167 yards; the breast above water-level was from 75 to 100 yards.

Black Mine Coal is distant from the Tunnel on the outcrop 68 yards. It is cut in a tunnel driven N. from the bottom of the Tunnel Coal Slope at a distance of 71⅔ yards. It is now worked, and is but 3 feet thick, its usual dimension being 6 feet. From this tunnel, on a lower level, the outcrop of the Black Mine Coal is 175 yards.

The *Little and Big Lawton* Coals, N. of Black Mine bed, are drifted on, but are not now mined, and were found, as far as proved, to be irregular.

The air-holes on the Tunnel coal are traceable from this point Eastward to half-way down the hill, descending to the gap at Preston's, opposite New Philadelphia.

From Upper Bare Ridge, 100 yards from Silliman and Reed's Breaker, a tunnel runs S. into Sharp Mountain 300 yards. It cuts the Parker Coal.

A tunnel was driven Northward in Bare Ridge, in the vicinity of Oliver's, known as the Andrew B. White Tunnel; it is now closed up.

The following Section exhibits the effects of an anticlinal flexure, cut by this tunnel, in alternately pinching and enlarging the coal-seams, all of which are in an unfit condition for mining:—

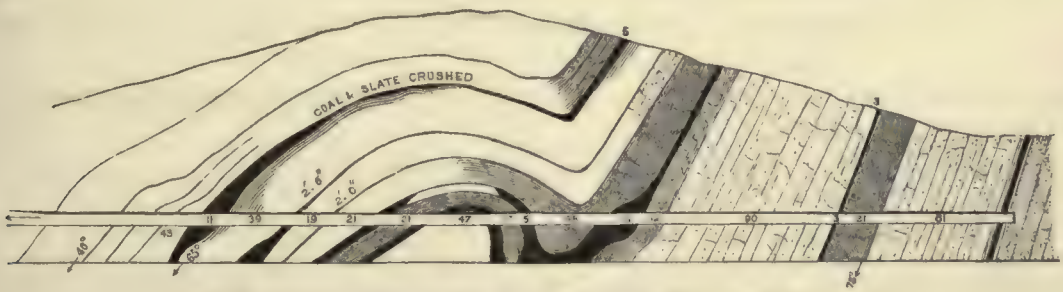


FIG. 167.—Section of Tunnel in Bare Ridge (Pott and White's).—100 *feet* = 1 *inch*.

ZACHARIAH'S RUN.

On the road between Silver Creek and Zachariah's Run, about one-fifth of a mile along the strike from the Valley Furnace, are two old tunnels, driven S. very close together. They

crossed the outcrop of the coal in the sandstone which lies beneath, then passed into more Northern measures in descending the hill to the Eagle Hill Colliery.

Above Eagle Hill Colliery on Zachariah's Run :—

1. The *Dodson* Coal outcrops near the Shanty, about 500 feet above or N. of the uppermost coal synclinal.

2. The coal of the synclinal axis has a S. dip of about 40°, and a N. dip nearly perpendicular, being from 75° to 80°. The coal ranges from 6 to 10 feet in thickness, being 8 feet when perpendicular. On the W. side of the valley the two limbs of the coal are together, and make a mass of 20 or 25 feet of coal.

3. The *Little Perpendicular* bed is separated from the above coal by a conglomerate. It is a 2½-feet coal, dipping from 80° to 85° N., and is opened on both sides of the valley.

4. The next coal is of a steep S. dip (80°), and is called the Diamond; it is about 5 feet thick, but 200 yards up the hill it was 13 feet thick, though soft and worthless. It is distant from the Little Perpendicular about 150 feet.

5. Two coals are known between this and the Gin Vein. The N. one is opened on the W. side, and is found to be 7 feet thick, and inclining nearly perpendicularly to the S. It is about 300 feet distant from No. 4.

6. The *Bosbeshell* Coal is the North-dipping coal which follows next. It is regular, but soft, and very close in the hill to the South-pitching Gin Coal. The drift in the Gin Coal divides, so as to give access to both sides of the synclinal: the N. dips are about 70°, and the S. dips 40°. The North-dipping coal is good below, but grows bad followed upwards. The S. dip is very good downward. It is nearly all worked out. The Gin Coal of Chadwick, Dovey, and Southall, Silver Creek, is not the Gin Coal of Zachariah's Run, which, by our construction and tracing, belongs to—

7. A North-dipping leader, about 1 foot thick.

8. A good coal, about 4½ feet thick, having a N. dip of 80°. This is the North Diamond Coal, proved by tracing of the axes and the harder rocks. There is hard conglomerate beneath.

9. The Perry or Brook's Coal is 150 feet S. of No. 8; dip nearly perpendicular. This is on the N. side of the anticlinal of sandstone (Axis No. 5), and has been worked to meet the same on the S. flank of the same arch in a S. dip.

10. The Henderson Coal corresponds to No. 8 above; dip S. from 30° to 35°, about 4 or 4½ feet of coal; the bottom is rough, the top is good coal. It is also called Green Park.

11. *Fitzimmon's Coal.*—Dip 40° S.; it has from 8 to 9 feet of coal in two benches—1st, about 2 feet of good coal, then 2 inches slate; 2d bench from 6 to 7 feet of coal. The vein is said to be the best in this valley. It has been driven E. 600 yards. The *iron ore* about 15 yards below the Fitzimmon's Coal has been driven into for exploration.

Some 80 yards (? feet) from the mouth of the drift, thin dirty coal was found, which met the Fitzimmon's. Near the meeting there was a thickness of dirt and coal of some 30 feet; the small leader dipping S. only 20°. This is probably the small leader (No. 7) brought into contact with No. 11 by a fault. The form of the ground is peculiar.

Above the Fitzimmon's are about 50 feet of olive slate and shale, then Pea and Shot conglomerate and sandstone, all dipping about 30° S.

12. A small South-dipping coal, of 2 feet thickness; was not wrought.

13. *Rough* Coal, 7 feet thick; S. dip 35°.

14. *Peach Mountain*, so called, underlying slate and rock from 4 to 5 feet.

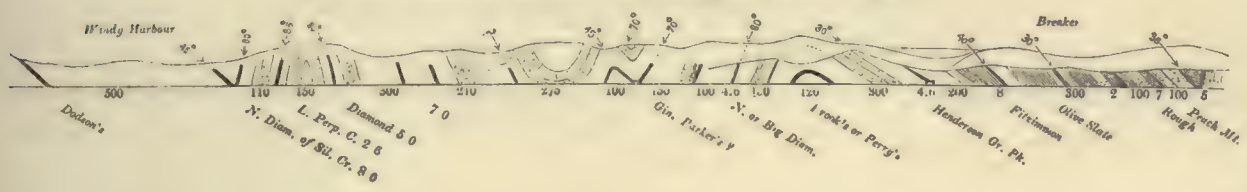
It seems probable, from careful tracing, that the synclinal bed of the Peach Mountain Coal of Zachariah's Run is the synclinal of the real Peach Mountain of East Norwegian. In this case the conglomerate which crosses Zachariah's Run at the Breaker is that which underlies the Big Tracey on Mill Creek. By both topographical and geological features the continuity of the Peach Mountain basin of Norwegian with that of Zachariah's Run seems to be fully proved.

Remarks upon the Zachariah's Run Section.—1st. The veins S. in descending order to the Breaker belong to the Tracey group; 2d. Thence down to the conglomerate of axis H to the Fitzimmon group; 3d. Thence below to the Diamond group. Thus the Gin Coal of Zachariah's Run is of the Fitzimmon group; the Perry is of the Diamond group, and probably the third from the lowest of that group.

Eagle Hill Colliery, Zachariah's Run—(Benjamin Titus, lessee; estate of Hewes and Baber).—Here the S. dips of the Peach Mountain are very regular, being about 35° S. There is also a perpendicular coal; the distance between the two outcrops is 11 yards. The owners have shafted on both beds, and determined the dips with accuracy: the coal, therefore, continues into this valley. S. of these are three or four beds, the Big and Little Tracey, &c. All the coal now taken (1853) is from the Gin Coal, about 500 yards N. of the Breaker.

The following cut represents the coal strata as they are developed on Zachariah's Run, with the local names of the coal-beds. It embraces nearly all the Red-Ash measures.

Fig. 168.—Section on Zachariah's Run, looking E.—1 *inch* = 400 *feet*.



BELMONT (FIVE POINTS).

Lewis and Spohn Coal of Belmont.—For the purpose of ascertaining the identity of the coal between Mill Creek and Belmont, the following examination and measurement were made:—

It was noted that the Sandrock Coal of Mill Creek had overlying it a massive Pea and Nut-conglomerate. This conglomerate was found on the bank of the river a little E. of Belmont, dipping 30° S. Measuring from the face of this conglomerate at water-level to the outcrop of the Lewis (so called), it was found to be a distance of 430 feet, which, when reduced to the horizontal, is about 335 feet—the true distance from the conglomerate face to the so-called Lewis Coal. This distance agrees so well with the distance between the same conglomerate and the *Sandrock* Coal on Mill Creek, as to lead us to conclude that the Lewis of Belmont is the *Sandrock* of Mill Creek.

After thus ascertaining their identity, it was found, by tracing the measures on the road from Belmont to Cwmbola, and also by the plotted map of the gangways of the respective workings, that the so-called Lewis of *Cwmbola* is also the Sandrock Coal. Both lie at the same distance N. of the conglomerate. Traced further E., the true Sandrock ranges into the swamp opposite Connor and Roads at New Philadelphia. The *true* Lewis, or so-called Spohn, crops out on the road from beneath its sandstone, and the true Spohn is worked by Connor and Roads.

Belmont Slope.—This slope is down on the local Lewis (true Sandrock) Coal. The length of slope in 1853 was 240 yards. Coal equal to 5½ feet in two benches—the lower 1 foot, and the upper from 4 to 4½ feet. The coal is good, and dips 35° S. Gangways run W. 600 yards. For the last 100 yards the gangway curves about 10° W., the bed having a dip of 30°. A

gangway runs E. 540 yards. There are three lifts in the slope. The coal has 2 feet of hard slate above it, and 3 feet of slate below; also a band of crushed coal or dirt, and a leader of 3 or 4 inches.

S. of the Sandrock Slope, about 70 or 80 yards, is a coal from 4 to 5 feet thick.

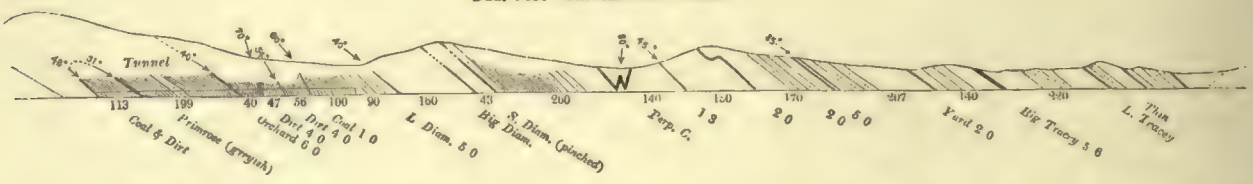
From 20 to 25 yards under the Sandrock is a 2-feet coal, locally called the Yard.

About 90 or 95 yards under the Sandrock is the Lewis (local Spohn) Coal. It has a slope sunk upon it down 140 yards, 120 yards below the water-level. It has two lifts.

From 6 to 9 feet from the top of this coal there is a 2½-feet coal, beneath which are 2 feet of slate, 4 feet of fireclay, and 2 feet of slate again. The Lewis is about 3½ feet thick in two benches; the lower is from 1 to 1½ feet; the upper about 2 feet—dip 37° S. The gangway was driven W. about 600 yards. 40 yards from the end, the vein turns towards the W. as the Sandrock does. These 40 yards are confused and faulty.

Ravensdale Tunnel.—The farthest coal cut in the tunnel dips S. 45°; it meets the Primrose Coal dipping S. 35°, and forms an inverted axis; the two coals are about 50 yards apart in the

Fig. 169.—Ravensdale Tunnel.



tunnel. The back or N. coal is 10 feet thick, and the Primrose is 7 feet thick. The Back Coal is locally called the Tunnel Coal. The crown of the arch would be about 50 feet above the tunnel-level. Between the two limbs of the anticlinal we find sandstone in part. The Back Coal has a breast of 63 yards; it contains much dirt. The crest of the anticlinal dips towards the E. until it reaches the gangway-level.

A leader was struck about 12 yards N. of the Primrose from the E.; the gangway runs 400 yards from the main tunnel. It is 3 feet thick, and is probably folded like the Primrose bed. It lies *under* the sandstone. They both crop out on the surface about 30 yards W. of the tunnel, separated on the surface by only a few feet of slate.

The bottom bench of the *Primrose* Coal contains 18 inches or 2 feet of Bony coal; the top bench is good coal, from 4 to 5 feet thick; the roof is a soft slate, and a thin sandstone without pebbles.

About 66 yards S. of the Primrose Coal, in the tunnel, is the Orchard Coal, dipping about 40° S. It is 4 feet thick, and is a true *Red-Ash* coal. The Orchard Vein was worked out to the E., and found very faulty. To the W. it has been worked into Crow Hollow until it ceased to be good coal. Between the Orchard and Primrose beds are soft slates. Over the Orchard we find 4 feet of slate and then hard sandstone, but no important seam of coal. There are two small seams, neither of which will measure 2 feet: there is a mere leader between them. It is 92 yards from the Orchard Coal to the tunnel's mouth. Outside of the tunnel, at a distance of 36 yards, is a small leader, and 40 yards S. of the tunnel is a coal dipping S. 40°, called the Diamond (see Ravensdale Section). The South Diamond has been found only on the W. side of the hollow dipping S. A coal, which shows itself on the W. side of the hollow, is not here known. There are here two *perpendicular* beds, each 5 feet thick, and separated by 10 feet of rock; they

are much confused, and form a double fold like the letter W. The N. one of these, worked E., became thin, and was found 46 feet from the other. The S. perpendicular was worked E. for 400 yards. It was worked by a gangway at three levels. The hill, containing the perpendicular coal on its S. side, terminates in a ravine opposite the mouth of the tunnel.

S. of the perpendicular bed is a coal about 15 inches thick, dipping steeply S. It has been shafted on. 75 feet S. of this, on the outcrop, is another seam. This coal basins and saddles on the hill, and the outcrop at the water-level is at the foot of the Breaker. It is underlaid by a hard sandstone and a little pebbly rock: it has not been worked.

We have next a considerable thickness of sandstone and olive slate, dipping S. 30°, opposite to the Breaker. S. of this, and almost upon the sandstone, is a double seam. The N. or bottom bench is about 5 feet thick, and the upper is 3 feet thick, with 2 feet of slate interposed.

At the bend of the railroad in Ravensdale Hollow, near the houses, is a quarry of sandstone dipping S. 35°. It has all the features of the sandstone which lies under the Peach Mountain Coal. It is overlaid by olive slaty bands, and by the small pebbly rock seen in the turn of the road on Mill Creek in the synclinal of Peach Mountain at Old Tracey Drifts. This quarry shows some 30 feet thickness of rock, which is seen forming a crest on the W. side of Ravensdale. S. of this is a sloping shaft, showing a coal and overlying slates, with regular S. dips of 35°; and S. of it again an outcrop of sandstone, seemingly identical with that on the N. side. Between these two outcrops is the Peach Mountain basin, very narrow.

Immediately N. of the axis of the tunnel there is a South-dipping coal, the return of the Primrose N. dip.

CROW HOLLOW.

In descending the hill to Crow Hollow, near its head, there is a coal cropped on by Silliman: it is probably the Black Valley bed. On the E. and W. trend of the road in the S. side of the Crow Hollow ravine is the outcrop of the Black Heath Coal. The Big Coal is not many feet under the bed of the valley at the tunnel, and rises with a very gentle ascent; then, towards the S. again, we see at the roadside descending Crow Hollow, the Primrose hard rock; over it the first S. dip, then the N. dip, and then the second S. dip at the old air-hole.

South of this is the outcrop of the Orchard Coal crossing the valley. The Primrose is worked through from Ravensdale to Crow Hollow on the first S. dip, and on the N. dip, but not on the second S. dip. It is worked for a short distance towards Mill Creek on the W. side.

The Orchard Coal is worked W. from Ravensdale to Crow Hollow, but is not worked on the W. side of Crow Hollow at all.

The Hancock Coals are not worked either on Ravensdale or Crow Hollow.

The Lower Diamond bed is mined through from Ravensdale to Crow Hollow. On the E. side of Ravensdale it is worked for a short distance.

The Big Diamond bed is not opened on Ravensdale or Crow Hollow.

The Upper or South Diamond Coal is drifted from Crow Hollow eastward a short distance: it is not worked on the W. side, nor opened at Ravensdale. The rock over the Diamond group is visible in Crow Hollow.

The Perpendicular Coals are seen in Crow Hollow. Here the synclinal belt is a confused basin, with very much the features it has on Ravensdale; but the coal was better on the N. dip

through to Ravensdale than anywhere else. It was confused Westward for 500 yards; indeed, there was no good coal, except, perhaps, 1000 tons.

A boring by the North American Company, sunk to 385 feet, struck a coal-bed said to be 7 feet thick; and several smaller seams were struck before reaching this 7-feet bed, one of them 4 feet thick.

MILL CREEK (ABOVE ST CLAIR).

Structure East of Johns' Colliery.—The outcrop of Johns' Seam on the N. lies along the flank of Mine Hill, and is traceable for a great distance E. The shaft opened by Samuel Silliman south of this line marks, we think, the continuation of the anticlinal disturbance seen in the small arch or wrinkle of sandstone near the slope on Mill Creek. This may be conceived, in its extension Eastward, to become a sharp anticlinal fracture, with perhaps some inversion at the surface, bringing the conglomerate and subjacent sandstone, which all lie above the Johns' Seam, into nearly vertical dips, and making the coal near the surface to take a like position. The main broad anticlinal to the S., in expanding Eastward, and being stripped on its summit and on part of its S. slope, not only of the great overlying coal, but also of the conglomerate which lies beneath it, brings to light a small coal which has here been shafted into on the N. side of the flat anticlinal near its crown.

A shaft sunk by Samuel Silliman struck coal dipping perpendicularly, and by tunneling N. and S. it has been proved to be 70 feet thick. The Nut-conglomerate is seen about 35 feet S. of the shaft, dipping steeply to the S. Some persons regard this as the N. side of the anticlinal, and the coal, the N. or perpendicular dip of Milnes and Snyder's Seam.

Johns' New Slope.—The coal here dips 38°. In 1853 the slope was down 60 yards. Thus far the coal was very regular: it had three benches; the upper one contained 3 feet of coal, the middle 7 feet, declining rapidly Eastward, and one-fourth of a mile off was only 2 feet thick, the rest being dirt. The lower bench was from 17 to 30 feet thick.

ST CLAIR, MILL CREEK.

Pinkerton's Tunnel is 700 yards W. of the Breaker, and runs from the Seventeen-feet Coal, so called, to the Mammoth. Over the Seventeen-feet Coal are 30 feet of soft slate, then thin coal, then coarse conglomerate rock 180 feet.

The Mammoth Coal is from 18 to 24 feet thick; the dip from 28° to 30°. At the tunnel, the slate between the Mammoth and 7-feet coal is 12 feet thick: the coal averages 7 feet thick; it runs from 5° to 10°. On the top of this is a sandy slate and argillaceous sandstone 12 feet thick, which runs to nothing one mile to the W., then coal 3 feet. S. from the 3-feet coal, we pass slate or shale with iron ore to the Black Valley Coal, which is 4 feet thick.

Milnes and Snyder's New Slope.—This, in 1853, was 278 yards long. It entered at 158 feet above the level of the railroad at St Clair. The dip of the Slope is S. 10° W.; it is slightly flat for 100 feet in the bottom of the Slope, then ascends 5° for 90 yards; then again, at the bottom of the Slope, a gangway is driven W. at right angles for 130 yards. Another gangway-level is going off from the bottom of the Slope, and is flat all the way. Driving Eastward, the coal rises in all directions, basining. The dip of the Slope in the lower level is 18° S.

M'GINNIS'S NEW SLOPE N.E. OF ST CLAIR (CAREY'S PROPERTY).

The Slope was sunk 165 yards; a hole was driven 76 feet further, to prove the dip of the seam. The dip of the Slope was 17° S.; dip of the coal in the hole 35°. Had in 1853 one lift, gangways E. and W. from a point 140 yards from the top of the Slope, the E. gangway driven 125 yards, and W. 200 yards. The gangways are somewhat winding. From each gangway, tunnels are driven S. to the 7-feet coal. On the E. side the tunnel is 10 feet 3 inches long; on the W. only 7 feet. The Mammoth bed is from 18 to 25 feet thick, the overlying seam is from 7 to 9 feet thick. The basin was not then reached. The basin of Milnes and Snyder dips to W.; therefore, though this slope starts at a lower level, it had not gained the coal.

Carey's Shaft—This coal-pit is situated a short distance S. of axis F of the basin *F G*. Its dimensions are 10½ feet by 18 feet. It intersects the Primrose Coal at 122 feet below the surface, and the Mammoth or Big White-Ash bed at 438 feet. From Carey's Shaft to Pinkerton's outcrop of the Mammoth Coal is 740 yards in a N. and S. line. The boring which preceded the shaft or pit, only recently completed, indicated three coal-beds, two of them very thin ones, between the Primrose seam and the 7-feet thick companion coal of the Mammoth bed. That next beneath the Primrose bed is the Flowery Field Coal of our Section: it is called on Mill Creek the Holmes Coal.

The annexed Table displays the depths at which the several coal-seams were reached, and approximately the nature of the strata between them. No boring can be deemed accurate in its indications of the thicknesses of the coal-seams, as Bony coal, and even very coaly shale, are sometimes mistaken for true working coal.

TABLE.

	Thickness.		Depth from Surface.	
	Feet.	Inches.	Feet.	Inches.
Rock and slate,	119	0	...	...
Primrose Coal,	3	0	122	0
Rock and slate,	68	0	...	...
Holmes Coal,	4	6	194	6
Rock 64 feet, slate 10 feet,	74	0	...	...
Coal,	1	0	296	6
Slate,	51	0	...	...
Coal,	1	8	322	2
Rock 54 feet, slate 18 feet,	72	0	...	...
Coal, 7-feet vein,	8	6	402	8
Slate,	14	0	...	...
Mammoth White-Ash,	22	0	438	8

BORING IN CROW HOLLOW IN BASIN *FG*, ON THE ESTATE OF THE NORTH AMERICAN COAL COMPANY.

An experimental boring was completed in 1853, under the direction of Mr P. W. Shaeffer, mining engineer, to test the depth of the Mammoth White-Ash Coal on the lands of the North American Co., in the belt I have called basin *F G*. It was judiciously located a little N. of the

outcrop of the Primrose bed. A shaft sunk here will command a good field of the thick and valuable Mammoth seam, in the somewhat gently South-dipping side of the basin *FG;* but the rather abrupt axis G is likely to intercept the progress of mining Southward, after passing the synclinal axis, distant from the boring only a few hundred feet. The following Table exhibits the strata penetrated by the bore-hole. A comparison of it and the preceding table betrays some curious discrepancies in the thicknesses of the strata, especially the sandstones, ever the most inconstant members of our anthracite Coal-measures.

TABLE.

	Thickness.		Depth from Surface.	
	Feet.	Inches.	Feet	Inches.
Sandstone, slate, and rock,	88	1	...	...
Holmes Coal,	4	2	92	3
Sandstone and slate,	57	5½	149	8½
Dark-brown slate, with iron ore and a seam of coal,	35	0	184	8½
Slate, with leader of coal,	10	2	194	10½
Rock, and some slate,	189	1½	384	0
Slate,	21	0	405	0

to the Mammoth White-Ash Vein.

MILL CREEK, SOUTH OF CAREY'S SHAFT.

There is a 2-feet-thick coal N. of the *Orchard Seam* on Mill Creek. The latter bed should, from its angle of dip and the position of its outcrop, intersect the shaft, but it has been looked for in vain. The inference is, that it turns away towards the N. as it descends ; it may, therefore, basin with the coal above mentioned. The Orchard is about 3 feet thick ; there is nothing but fine fissile slate between it and the small coal, and the same exists between the two Hancocks. The two Hancock beds form a folded trough : they are distant at the outcrop on the hill about 50 feet ; at the drift the distance is scarcely 10 feet, and a few feet below this they come together. There is a small anticlinal or roll between the Orchard and the Hancock Coals. The Hancocks are about 3 feet in thickness each, and were once worked about 150 yards E. of Mill Creek.

The *Big Diamond* Coal, 7 feet thick, worked at the slope, is found to flatten as it descends. About 200 feet below water-level it is flat, and then turns up. At the flat part it is more than double the ordinary thickness ; but, ascending on the N. dip, it is crushed and worthless, being not more than 15 inches in thickness.

The *North Diamond* bed is here a mere leader, and worth nothing. The South Diamond Coal is reported to be from 4 to 5 feet thick, and is traceable as the Green Park from East Norwegian to Mill Creek. This coal, certainly identifiable as such, is struck on the saddle in M'Ginnis's Shaft and Boring on East Norwegian.

Between the Yard and the Peacock Coals on Mill Creek are *three veins.*

The *Primrose* Coal on the E. side of the workings has a bottom of 3 feet of Bony coal ; it contains 6 feet of good coal.

The position of the N. outcrop of the Peach Mountain Coal is near the Summit Tavern, W. side of Mill Creek. Between the Big and Little Tracey Coals, the chief rock is a sandy olive

slate, or flaggy sandstone, passing upwards into olive shaly slates, weathering very ochreous. *Above* the Little Tracey are similar olive slates, passing upwards into sandy slates and flaggy sandstone, grey, greenish, and rather soft, often coarse, and sometimes pebbly. Above this, and immediately under the Peach Mountain Coal, are ochreous olive shaly slates.

Peach Mountain Basin, E. Side of Mill Creek.—From the Big Tracey Coal across the measures to the Little Tracey bed is 140 feet. From the Little Tracey to the synclinal axis of the conglomerate the distance is 200 feet. There is no room here for the Peach Mountain Coal.

UPPER RED-ASH COALS OF MILL CREEK.

Beginning with the Main Gate Coal on the E. side of Mill Creek Valley, and advancing N., the first coal is the *North Gate*, distant 175 feet, and the rock between Gate and North Gate is a coarse grey sandstone, slightly conglomeritic (pebbles pea size), and then thick shales.

2. The 2d *North Gate* is N. of the 1st 95 feet, and between it and the 1st North Gate are only argillaceous sandstones and shales. A few feet above the 2d North Gate there is a coarse angular speckled pebbly sandstone, the pebbles few, and only in certain layers. It is perhaps from 10 to 12 feet thick.

3. About 62 feet N. of the 2d North Gate bed is the 3d *North Gate*, in fault, and about 10 feet above it is a sandstone.

The white conglomeritic sandstone at the turn of the road, 670 feet from the Gate bed, is probably the same as that of the hill at the Norwegian at Temple's Tavern. A little coal in fault at 710 feet from the Gate bed is probably the coal of the synclinal axis.

A hard grey speckled sandstone, 10 or 12 feet thick, succeeds, which may be detected in the synclinal axis, where it is deeper than at Temple's synclinal on Norwegian. The position of the Little Dirty Coal (Temple's) is to the N. of the turn in the road. Then come the conglomerate and other measures on a S. dip, from 35° to 40°, all corresponding with the N. dips.

The Little 3d North Gate, under the name of the Little Sandrock of East Norwegian, overlies at the proper distance of, say 12 feet, a rough conglomerate and sandstone.

The *Big Sandrock* Coal is seen on the roadside, and in the drift under the road. This is the 2d North Gate Coal. A drift on the W. side of the valley is on same coal.

The *Yard* Coal of East Norwegian, or 1st North Gate, is opened by an old drift. There is a small coal above the Lewis, which is the small coal N. of the main Gate. All the elements agree, and this view of the identity of the Lewis and Gate Seams was maintained by Mr John Madison, an estimable mine-viewer, several years ago.

The *Little Lewis*, or Little Spohn Coal of Belmont, crops out South of the Lewis about 25 or 30 feet.

The *Lewis* Coal colliery is that of Snyder and Milnes, and that on the opposite or W. side is the colliery of Mr Bainbridge. There is no true Spohn Coal here, but a small 18-inch coal N. of the engine-house; then the *Palmer* Coal at the drift.

A massive sandstone, pebbly, somewhat grey and speckled, lies between the Lower Lewis and the Palmer; it dips 30° and 35°. Then directly over the Palmer is coarse sandstone, then coal, with olive shales between it and conglomerate, dipping 45°.

The Palmer answers to the South Gate Coal. It here averages 3 feet in thickness, one solid

block. The so-called *Spohn* Coal dips from 30° to 35°; it outcrops on the road opposite the S. end of the barn. It averages 6 feet of coal.

Above the house are two coals at an old drift; the first S. is the *Robert Waln* Coal, dipping 70° S., but faulty. Its thickness averages 7 feet. Soft measures occur between it and the *Clarkson* Coal, with gentle dip. There are 6 feet of coal here. The tunnel runs from the Spohn to the Waln Coal.

The *Little Clarkson* dips from 20° to 25°. It has 3 feet of coal.

A supposed coal is said to occur in the interval.

The *Cellar* or *Stevenson* Coal is to be seen at an old drift on the roadside.

We now cross a hollow, and pass a small coal at a spring in the meadow, and another small coal just opposite the S. end of the North American Company's Mill; then the *synclinal axis* at the N. end of the mill.

The rocks are argillaceous flaggy sandstone; then a small coal repeated on a S. dip, and another small coal in a quarry N. of the sawmill.

North of a white house on the roadside there is a small coal which rolls and turns into a N. dip. This spot corresponds to the confused measures near the furnace on the opposite side of the valley. Over this small coal there is a shale, then sandstone and conglomerate in the basin at an angle of the road. The dip is gently S., to all appearance in the same sandstone. This is the conglomerate of the turn of the road on the W. side of Mill Creek near Summit Tavern.

On our line at the road is a drift in the Little Tracey Coal in position under the conglomerate. The Big Tracey Coal drift and shaft are at a ravine at the turn of the road. The dips are gentle, from 25° to 30°. A coarse sandstone overlies it.

It is thought by some that the Little Tracey of this side is the coal called the Clinton on the other, and the Big Tracey, the Peacock.

Between the Big Tracey and the Yard Coal is seen on the road a coarse conglomeritic sandstone. In a quarry of flaggy sandstone and shale there is a little coal in fault. The Yard Coal dips here 42° S. Next under this is the outcrop of a grey-speckled sandstone with yellow specks of oxide of iron, 10 feet thick; this bears for the slope belonging to the Clinton Coal on the W. side. Next N. of the faulty coal, opposite a small house at the bend of the road, is a coal, probably the true *Clinton* seam. It is that on which the slope is sunk at the Great Dirt-heap. It varies in thickness from 4 to 9 feet, and is thickest when dipping steepest. It is sunk upon through 70 yards in the slope. Under the Clinton, about 30 feet, there is a small 18-inch coal—the Perpendicular Coal of the W. side of the valley.

The South Diamond is in a drift S. of a white house (Mr Madison's), and the Green Park of the Furnace is there called the Diamond.

The North Diamond is the coal at the old engine-house on the W. side of the valley. It is 80 feet S. of the Little Hancock. A faulty small coal is in the slope. It is faulty at Wadesville (East Norwegian), but not at Oak Hill. It dips 25°.

An old drift at the S. end of the rubbish-heap is on the *Little Hancock*. This, on the West Norwegian, is a good coal of 20 inches thickness.

The *Main Hancock* Coal dips 25°; it is 3 feet thick, but faulty.

This ends the group of true Red-Ash Coals of the Mill Creek Valley.

On the W. side of Mill Creek Valley is the Yard Coal, here called by some the Clinton Coal.

A slope has been sunk on the Peacock Coal. It is worked at West Norwegian, but called there the *Clinton* Vein. The Green Park Coal of Mill Creek is that immediately S. of the furnace. It is apparently one of the Diamond group. It measures from 5 to 6 feet, and dips 45° S. Next is a dirt coal, not here opened, but it is opened on both Norwegian valleys.

The South Diamond, here so called, is next N. of the Green Park Coal. It is nearly perpendicular in the hollow, but only driven in 100 yards. Next N. is a coal worked by Nicholas many years since; it has a dip of say 45° S., with 4 feet of coal. Then the Big Diamond; thickness 5 feet; dipping 35° S. In this bed Richardson reached the bottom of a local narrow basin. The bed sent off a one-foot-thick leader, and rolled up into a N. dip. The mine was worked both E. and W., and good coal was taken from the S. dip, until a fault at both ends stopped them. The N. dip went up 4 or 5 yards, then turned over into a pinched S. dip—all faulty.

The Coals immediately above the Green Park Seam on Mill Creek are as follows:—

1. There is a 3-feet coal 90 or 100 feet above the Green Park bed, or 50 feet above the intermediate Little Diamond Coal.

2. A 3-feet coal shown by black dirt.

3. Another coal, about 7 yards below the Peacock, covered by a coarse sandstone, containing from 8 to 10 inches of iron ore, and upon this, the Peacock Coal, now mined by a slope. It is generally 7 feet thick.

The Clinton or Yard Coal is generally from 2½ to 3 feet thick.

Under the Primrose Coal on Mill Creek is the Black Valley or John Holmes Coal, from 3½ to 4 feet thick, carrying a little over it a small 6 or 8 inch coal. It was drifted and found in fault at 300 yards.

The Black Heath Coal occurs at Pinkerton's Breaker. It is only opened in black dirt at Pinkerton's Colliery, and seems to be about 5 feet thick, but was not worked at the period of our survey.

SINGLEY'S FARM.

Anticlinal J.—This axis forms a very sharp crest, the turn of the dip being on the N. brow of the hill, where the Clarkson Coal shows itself on the N. and S. sides of the axis-line in adjacent outcrops, the N. dip being steep. On the crest, and in the hollow next S., the dips repeatedly change, with crush and slight dislocation, of which there is a remarkable instance at the crest of the hill in the road.

1. The Lewis Coal crops out on a bench of the high hill S. of old Singley's house. It is 4½ feet thick. The gangway runs Eastwardly through the hill, and out to the next ravine. The dip is quite steep to the S. This coal is faulty for 300 yards towards the E., both above and below water-level; also on the adjoining property to the E. for 70 yards.

2. The Palmer Coal, which was worked out at Cwmbola, crops out about 300 feet N. of the Lewis Coal, but is not worked here.

3. The Chestnut Coal was worked on Mill Creek by Milnes below water-level, and by Spencer and Mason in a drift. It is from 3 to 4 feet thick, and crops out directly on the crest of the hill at the road. There was an iron stack upon it in the Orchard. It had been worked from Mill Creek 150 yards E. of this, or about 2000 yards E. in all.

4. The Clarkson Coal was opened on both sides of the crest axis. It is from 3 to 5 feet thick, and is worked from Mill Creek to the road at Singley's.

5. There is a small bed of about 18 inches thickness between the Chestnut and Clarkson coals; it was explored only on the S. dip.

6. A coal N. of the Clarkson bed, called the Robert Waln, dips nearly perpendicularly. It is 85 yards N. of the Clarkson, and is in the tunnel at Mill Creek: its usual thickness is from 4 to 6 feet, sometimes rather more.

7. The Stevenson Coal, dipping S.; about 4 feet thick; variable. The gangway runs only 36 yards.

8. A coal occurs in Singley's well, about 3½ feet thick; very good; dips S. It is 75 yards beyond the Robert Waln.

9. A coal dipping N. about 70°, 6 feet thick, just shafted on by Mr Singley. Very good Red-Ash coal, about 50 yards N. of the well.

10. A South-dipping coal, not very steep; 3 feet; worked only 150 yards: its outcrop is 150 yards from No. 9. The two would, of course, form a synclinal trough.

11. A coal dipping S., about 5½ feet thick; irregular: it has been shafted by Mr Singley. This crops out in the wood N. of the cornfield about 70 yards N. of No. 10. It is called here the Peach Mountain Vein. On the road, a few yards N. of the cornfield fence, the rocks dip steadily S.

12. A coal called the Bony Coal; Red Ash; is about 4 feet thick.

MILL CREEK (SOUTHERN PART) COLLIERIES.

Spencer and Mason's Drift on the Palmer Coal (Singley's Chestnut Vein).—The coal is about 3 feet thick throughout; dip 24½° S. The coal is good, in one solid mass, with no slate divisions. Above the coal is from 6 to 7 feet of fireclay—a loose poor top; above it is hard solid sandstone. The gangway runs E. about 2000 yards. At 1760 yards there is an air-stack: the breast measures 195 yards. It has been worked about twenty years.

Spencer and Mason's Spohn Coal Drift.—This is 44 yards N. of the Palmer; average dip 27° S., but varies greatly, sometimes being as steep as 50°, and sometimes nearly level. The coal averages 5 feet in thickness in three benches. The lower is 20 inches thick, and the best coal. The middle has from 20 inches to 2 feet of excellent pure coal. The upper has 15 inches of coarse coal. The gangway, when driven about 1000 yards E., reached a rock-fault which cut off all the coal except 6 or 7 inches. The drift was driven 140 yards through the fault, the coal varying from 7 inches to 4 feet in thickness. In 1853 it had been worked eleven or twelve years.

Snyder and Milnes' Lewis Coal Slope.—Down on the Lewis Coal, 125 yards from the top, and 100 yards below water-level, with S. dip of 35°, the vein averages 4½ feet in thickness. It has two benches; the lower is 2 feet thick, and the upper 2½ feet thick, with sometimes a little slate between. The top slate is good, and from 6 to 7 feet thick; on top of this is a leader with 18 inches of good coal; at the bottom is one foot of slate, then a 6-inch leader, and below this hard rock.

The gangway runs E. 1800 yards; for the last 500 yards the coal is faulty and crushed. From the bottom of the slope it was tunneled N. 215 yards. At 165 yards it is cut by the *Yard* Coal (?) only, 18 inches thick: they drove E. on it 1800 yards. The coal opens out to 2¾ feet in thickness, which it averages: it has a sort of soft fireclay top, with slate at bottom. In the tunnel is sandstone and conglomerate. At the end of the tunnel is the *Spohn* Coal, called the North Coal there. Driving E., the coal averages 3 feet in thickness. Faults are frequent; at the top is dirt, and sometimes Bony coal. This mine sends from 15,000 to 18,000 tons away.

Haven's Lewis Coal Slope.—This Slope was in 1853 down 185 yards, and 163 yards below the creek-level.

The coal was 7 feet of average thickness, in three benches: the top is 4 feet thick, with thin parting; the middle bench is 9 inches thick, with 18 inches of slate parting; and the bottom bench is from 15 to 20 inches thick. The top of the seam contains 2 feet of Bony coal: dip 32° S. on the first lift (100 yards); below that it is steeper. The end of the Western gangway is marked by a stack near the East Norwegian road.

There was nodular iron-ore 3 feet in thickness about 15 feet below the coal and sandy slates, and soft sandstone between it and the Slope coal.

There is a 3-feet leader N. of the Slope coal; then 40 feet of soft sandstone and conglomerate, dipping 40° S. to the *Spohn* Coal, which contains 8 feet of coal. *Above* the Lewis Coal is a bed, about 18 feet thick, of slaty sandstone, generally soft and crumbly, surmounted by a coal one foot thick.

The bearing from the tip of Haven's Slope to the tip of Snyder and Milnes' Slope is N. 72° E. by compass, showing the average strike of the Coal-measures.

From Haven's Slope to the office is 300 feet. Here is a quarry of ochreous sandstone, dipping 20° S. Above this are brownish and olive slates, continuing for 150 feet to a small bed of coal and slate 2¾ feet thick. Then yellowish and grey flaggy sandstone, weathering brown, S. dip 35°; and above this argillaceous slates, weathering brown, to the *Sandrock* Coal, 123 feet. Upon this lies a grey conglomeritic sandstone 15 feet thick. Its contact surface is very irregular; the thickness of the coal is about 3 feet: though not uniform, it contains not one foot of good coal. On the E. side it is 4 feet thick, and regular.

About 27 feet S. of this is the *Little Sandrock* Coal, and immediately under it are shales. Then 280 feet of argillaceous ochreous sandstone, slate, and shales, dipping, as above, to a small bed newly opened, above which is a coarse sandstone and Pea and Nut conglomerate, passing upwards into a flaggy grey sandstone.

The bearing of the outcrop of conglomerate on the E. side of the valley is N. 70° E. This rock, as exposed on the E. side, is a massive bluish-grey conglomerate containing blue slate, pebbles, as well as sparse ones of white quartz; dip 40° S. The white pebbles are seen running in narrow courses; over this is 20 feet of ochreous shaly slate, then 20 feet of conglomeritic sandstone like the preceding, 90 feet of arenaceous slate and shale, and ochreous or red sandstone on the surface, then 20 feet of coarse grey and brownish sandstone, dipping S. 40°. This is situated at the E. point of the hill.

PORT CARBON, MILL CREEK.

COAL-SEAMS IN THE GATE RIDGE ANTICLINAL FLEXURE.

The *Port Carbon Section* shows in the end of the hill a coal at 110 feet from the last stratum exposed at the road. It is the *Faust* Coal.

The *Rabbit Hole* Coal is at 250 feet. The Little Tunnel Coal comes above the Rabbit Hole, and

The *Main Tunnel* Coal occurs next. Under the Tunnel Coal is the hard sandstone of the hill of the Catholic Chapel.

The *Black Mine* Coal occurs between the Catholic Chapel and the road.

The *Lawton* Coal is next.

The *Belfast* Coal succeeds, and appears in a garden.

The Belfast Coal is seen again 57 feet S. of a stake at the edge of the street: the *Alfred Lawton* bed has a vertical dip: the anticlinal will be near the stake just spoken of.

The *Lion* Coal and the Alfred Lawton are probably the same bed, and on the W. side of Mill Creek appear at the anticlinal. The Lion Coal is called the Barn Coal.

To the Lion succeeds the *Ridge Gate* Coal, S. of the old engine-house. This has a dirt-bed on its W. side next S. of the spur, and is there called the Little Perpendicular. There is another coal just S. of a hard sandstone and conglomerate; it has no name, but it is also seen at an old drift on the W. side of the Pottsville Gap. The *South Gate* is about 100 feet N. of the last; and at about 200 further is the *Gate* Coal, within 50 feet of the stream. Again, on the road through the valley, the South Gate and the Gate are crossed. The former is 150 feet S. of the latter, with nearly vertical dips.

A careful revision of the ground occupied by the Lewis and Gate groups, leads to the following conclusions in regard to identity: that

The *Lewis, Gate,* and *Tunnel* Coals are the same:

The *Lower Lewis,* or *Little Spohn,* is the *South Gate* or *Blackmine* Coal:

Spohn, Palmer, Yard, Chestnut, of Spencer and Mason (iron air-shaft coal of Singley's Farm), are the same as the *Little Perpendicular Gate* Coal, or *Engine Gate,* and therefore the equivalent of *Selkirk.* This is sustained by the overlying conglomerate.

The *Little Tunnel, Rabbit Hole,* and *Nest* Coals, are the *Yard, Big* and *Little Sandrock* Coals.

Junction Tract (Property of North American Company).—The S. slope at the mines here is on the *Tunnel* Coal, which is identical with the Tunnel Coal of Salem Hollow. It was not worked E., except at Oliver's in Bear Ridge, and it is traced nearly opposite to New Philadelphia.

The first coal caught in Chillis' Hollow is the *Faust* Coal, which crops out near the tavern, while the Rabbit Hole crops out a little N. of the crest of the ridge of hard rock. The thickness of the Rabbit Hole at this locality is 2½ feet; and the distance between it and the Tunnel Coal is about 45 yards—the measures being chiefly sandstone.

The *Tunnel* Coal of this locality is about 4½ feet thick, and has upon its top about 8 feet of soft and bony coal and shale. It is generally overlaid with from 2½ to 3 feet of this matter. The dip is about 40° S. The gangways run E. and W. The coal lies in two benches, each bench containing from 2 to 2½ feet of coal. Between the two is a thin layer of dirt. The bottom bench contains rather the firmest and best coal. The distance from the Tunnel Coal back to the Blackmine bed is about 195 feet.

The Blackmine Coal is 4 feet thick.

At the Gin, a slope was sunk dipping to the E., the steepness of the dip increasing—this being just at the turn of the saddle. The coal appears to be in the position proper to the Selkirk Seam.

The *Randolph Tunnel,* in Sharp Mountain, is 365 yards long, and cuts ten coals: the thickest is 8 feet thick.

CHAPTER VII.

COAL-FIELD BETWEEN MILL CREEK AND THE WEST NORWEGIAN VALLEYS.

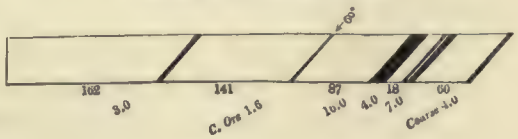
ANTICLINAL AND SYNCLINAL FLEXURES, AND THE COAL-BEDS CONTAINED IN EACH BASIN.

PROCEEDING, as in the last Chapter, to point out, before entering upon local details, the special parts of the Coal-measures which present themselves at the water-levels of the valleys, and in the hills between, in each particular basin formed by the several parallel anticlinal undulations of the coal-field, I shall commence my general description, as usual, with the most Northern belt, or that at the foot of Mine Hill.

Basin D E West, or that of Mount Laffy.—We have seen that on Mill Creek, the axis E in the Primrose Coal being an exceedingly feeble one, the basin before us contains at the water-level only the South-dipping strata belonging to the S. slope of the axis D, and that the coal-seams thus placed consist of all the upper White-Ash Measures, excepting the Skidmore bed, which is on the anticlinal Arch N of the Mammoth seam; and also the lower Red-Ash beds, the Flowery Field and the Primrose. But on East and West Norwegian the anticlinal E, or its near equivalent, becomes a much bolder wave, or has a much broader North-dipping flank. The basin *D E* exhibits, therefore, a true North-dipping belt, visible in the Primrose seam at and above the water-level on both the valleys. On East Norwegian the coals seen above the general water-level are on the N. side of the basin; the Mammoth Coal, with its overlying 7-feet-thick companion-bed, and a little over this the Black Heath Coal; then at a horizontal distance of 290 feet, the Black Valley bed, and S. of this 206 feet the Primrose Seam. On the N. dip no coal has been opened but the Primrose, which just at the anticlinal axis reaches a moderate elevation above the water-level of the valley, sufficient to enable it to be successfully mined on both its dips, or N. into basin *D E*, and S. into basin *E F*. At West Norwegian the general condition of things is almost precisely similar, the Primrose Seam being here entered also at the anticlinal axis, and wrought from Brown's old slopes in both basins. It would appear, however, that either the basin is deeper by a slight descent of its synclinal axis Westward, or that the denuding waters have left within it a greater thickness of the coal strata, for it contains in its centre two seams of coal above the Primrose bed—the Big and Little Peach Orchard Veins—not preserved at the East Norwegian. A glance at the Sections will make these relations clear.

The accompanying is a Section of the Old Mount Laffy Tunnel.

FIG. 170.—Mann and Williams' Tunnel, Mount Laffy, looking E.—1 *inch* = 200 *feet*.



Belt E G.—The very feeble anticlinal flexure F of Mill Creek, there gently undulating the Primrose Coal below water-level, appears to affect the strata as far W. as East Norwegian, where it lifts the Orchard Coals to the general upland, high enough for them to be denuded at the axis. On the West Norwegian the corresponding anticlinal F West, or L of the Western

system, situated several hundred feet S. of the trend of axis F, is a flexure of greater breadth and height, and of much greater incurvation, its N. dips being nearly perpendicular, and its S. dips as steep as 40° in this quarter: therefore the belt E G includes two well-defined basins; whereas on East Norwegian it is rather to be viewed as one basin—that of Wadesville—with a roll or subordinate undulation 500 feet S. of its North-bounding axis E. On East Norwegian the anticlinal F does not quite bring the Primrose Coal up to water-level; whereas on West Norwegian, this coal, and its attendant 4-feet-thick underlying seam, span the axis F West in a well-defined steep arch. In the belt F G on East Norwegian, the lowest coal lifted to the day at the anticlinal G is that next beneath the Big Diamond seam; while on West Norwegian the effect of the supposed same anticlinal is to elevate a coal considerably lower—namely, the Little Diamond. It is a consequence of these conditions of the flexures, that while the Big Diamond, or the Dado Coal, is the highest workable bed of the Wadesville Basin, and the Primrose the lowest, the North Diamond, or Brown's Upper Coal, is the highest workable on West Norwegian, and the Primrose the lowest.

Belt G H.—The undulated belt G H,—viewing the anticlinal H as a persistent axis from East to West Norwegian, and the flexure H as dying out towards the Centre Turnpike Road,—is a complex or double basin on East Norwegian; and a single, or a very obliquely-crushed one, on the W. valley of that name. We know too little of the foldings of the strata in this belt on West Norwegian to pronounce with any certainty regarding the place of a folded synclinal axis, further than to state that it probably lies S. of the so-called Big or South Diamond Coal. At the valley of East Norwegian Creek, the coals called Big and South Diamond are separated by three intermediate thin coals. The South Diamond of that valley appears on both sides of the anticlinal axis H, and again just reaches the water-level at the axis H in M^c^Ginnes's boring. The highest coal in the basin *G H* is a seam next over this South Diamond bed; and the lowest on axis G a coal next below the Big Diamond, making in all seven South-dipping and two North-dipping outcrops in the basin, the synclinal axis lying very close to the anticlinal H.

Peach Mountain Basin.—The highest coal preserved in the synclinal bend of this wide and deep trough of the coal-field is the Peach Mountain Seam. This valuable coal has long since been entirely worked out above water-level from East to West Norwegian, and is by this time well-nigh if not completely exhausted down to its synclinal turn, even on West Norwegian, where the basin, there an oblique and compressed fold, is the deepest. The whole basin there, considering the anticlinal axis I as its true S. boundary, contains the outcrops of the three valuable coals—the Peach Mountain, Little Tracey and Big Tracey—besides a thin seam between the two former. The lowest coal lifted to the surface, on East Norwegian, by the anticlinal I, is the Big Tracey Seam, which is merely flexed at water-level by the anticlinal I into a very broad and flat swell on its N. dip. At the valley of Middle Norwegian the Peach Mountain basin appears to be more symmetrical than it is to the E. or W.: it contains the same beds as at East Norwegian, but is deeper and broader, holding originally a far larger amount of the Peach Mountain Seam. Here the Big Tracey Coal, retaining its name on the N. side of the basin, bears the name of the Chenoweth on the S. side, or where it dips North, to add to the confusion arising from the ignorance originally of the identity of the coals on opposite sides of the saddles and basins, and the consequent application of a separate name to almost every separate outcrop of this Big Tracey. Chenoweth Seam of the Peach Mountain basin is on the S. side

of the anticlinal I, called the Clarkson Coal, while the Little Tracey, passing the same axis, is named the Pearson Seam, the Peach Mountain bed itself being called the Barclay Coal. (May not the Barclay Coal represent the small coal between the Peach Mountain and Little Tracey, and the Spohn Vein be the true representative of the Peach Mountain Coal ?)

Basin i J.—A steep and much-compressed basin, or oblique South-dipping trough, is visible on both East and Middle Norwegian valleys, between the steep anticlinal undulation I and the sharply-folded South-dipping anticlinal J. On East Norwegian, the anticlinal J exposes above the water-level the Big Tracey Coal known as the Clarkson north of the inclined anticlinal axis plane, and the Mason Coal south of it; *both*, however, dipping South. As a consequence of this structure, the Peach Mountain and Little Tracey coals, and probably one or two seams higher, lie in the middle of the basin, with both sets of outcrops dipping steeply Southward ; the S. set belonging, of course, to the inverted portion of the beds. To identify either of the greatly crushed and faulty seams of this folded anticlinal with either of the well-known beds of the Peach Mountain Basin, is, in the present state of our knowledge of the ground, impossible. It might, perhaps, have been practicable twenty years ago, at the period of the most active operations of the East Delaware Mines, but in the present dilapidated and inaccessible condition of the old gangways, and the absence of deep slope or pit workings, the co-ordination of the seams is too uncertain to be ventured upon.

Crossing over to the Middle Norwegian, the anticlinal flexure J, already beginning to subside, has converted its inverted N. flank into a perpendicular one at the North American Company's mines in this valley. The uppermost coal-bed of the basin *i J* is the Spohn Seam, which, on the N. side, dips S. 30°, and on the S. side is perpendicular, and is called the Perpendicular Coal. It is squeezed from a thickness of 7½ feet to one of 3 feet. This seam spans the anticlinal J at a high level, and becomes the well-known Lewis Coal of the adjoining basin *J K*, dipping again S. 30°.

Every effort to identify this important anticlinal flexure, which separates the Lewis and Spohn Coals on the W. side of West Norwegian, has hitherto proved abortive, though their identity has been established, it is thought, beyond question, by actual mining ; the workings belonging to the two outcrops coming together a little E. of this valley being separated by merely a fault or jumble of the strata, the apparent running-out of the sharp axis J.

Basin J K, or that of West Norwegian.—Between Mill Creek and the West Norwegian Valley the synclinal trough included between the anticlinal axis J and that of the Gate Ridge K is broad, deep, and regular. On Mill Creek, as our Section of the strata at that valley shows, its central portion is nearly symmetrical, the N. dips not much exceeding the S. ones until we approach the Gate axis, when they become nearly perpendicular. The Gate Ridge anticlinal is there a steep normal flexure, its S. dips amounting to 45°, and its N. ones to 85°. Further W., between Salem Hollow and East Norwegian, and again at Pottsville, the North Branch of the curve becomes inverted, dipping indeed at even as low an angle to the S. as 40° ; but this inversion does not extend quite to the synclinal axis, as may be seen by consulting our Section of the Middle Norwegian. Between Pottsville and the West Branch the inversion or folding at the anticlinal still prevails, as the West Branch Section indicates, but it is probably at its maximum near Pottsville. On the other hand, the synclinal flexure is rather more compressed or folded on the West Branch of the Schuylkill than on the Norwegian north of the town.

The uppermost coals of this Norwegian basin are those of the Salem group, or the highest Red-Ash group of the Schuylkill or Sharp Mountain basin. These have not been opened on Mill Creek, from the circumstance that they have too little breast above water-level, and being, moreover, in a shallow basin, could not repay the expense of mining by machinery, even should they prove thick enough. The pinched and folded condition of the basin at the N. foot of the Gate Ridge, renders it doubtful if the Salem group is present opposite East Norwegian, or at the mouth of the middle valley of that name; but there can be no doubt that the Sandrock group, or the coals next lower in the formation, are there embraced at the synclinal axis. This basin would thus appear to contain a very extensive series of the upper Red-Ash coal-beds—in other words, all the Gate group, the Sandrock group, and the Salem group; but it would seem, as already intimated, that it becomes somewhat less capacious as it ranges Westward. It is probable that the synclinal axis gradually rises in that direction, from the introduction of one or more anticlinals Q and Q Q of West Branch, and from an increased amount of folding of its South-bounding anticlinal K.

Basin K, or that of the Schuylkill at Pottsville.—This, the most S. synclinal trough of the coal-field, is at the same time the deepest and most capacious; its general structural features and its contents have been already so fully indicated, that a detailed description of it, beyond that which is given in the Sections and in the notes of localities which are to follow, is not called for. It may be expedient to mention, however, in observance of the mode of description of the other basins, that this trough contains the entire series of Coal-measures to be met with in the Southern coal-field, its S. border in the N. slope of the Sharp Mountain exposing all the lower or White-Ash coals, and its central or synclinal belt—occupied in part by the immediate valley of the Schuylkill—containing the very highest of the Red-Ash seams. It is not meant by this that every coal-bed met with in the region has an equivalent seam in the Sharp Mountain and Schuylkill Valley, for the coal-beds of the region are not all of them continuous, some, even very important and thick ones, thinning out altogether, while others replace them, seldom upon the same horizon. As no one locality or district assembles the several coals of the coal-field at large, we should not wonder that the local basin of Pottsville embraces, as it appears to do, a less number of beds than a general enumeration, covering all the districts of the region, exhibits. The Sharp Mountain side of the basin, from the upturned and squeezed condition of its strata, presents its coals in so crushed and faulty a condition as to render the identification of many of them almost impossible; and their unpromising condition for mining having prevented some of them from being fully explored, we are even left in some uncertainty as to their total number. The best conception of the contents of the basin, and the conditions under which its coal-beds exist, will be got from a careful study of the Norwegian Sections, and of the shorter Sections illustrating the Sharp Mountain. The synclinal axis, or central line of the trough, appears to be deepest between Pottsville and Port Carbon, for the Salem Vein worked at Port Carbon seems to basin out before going very far E.; and a careful tracing of the strata has satisfied me that there is a perceptible rise in the opposite direction, from the mouth of Salem Hollow to the Main Street of Pottsville at Silver's Row. The very bend of the synclinal flexure is well exposed in a hill-side cutting, just back of the street, in the rear of the row of houses mentioned, and the strata there displayed appear to be those which immediately overlie the South Salem seam of the Schuylkill, but at a higher level; the axis is also to be seen on the road by the river-side E. of Salem Hollow. Its direction by compass to Silver's

POTTSVILLE IN 1840, FROM THE NORTH.

Row is precisely S. 72° W. It is probable that the two coals in the synclinal axis at the Brewery lie in the hill above the street, and that the double crushed coal S. of Silver's Houses is the South Salem of Salem Hollow, and the crushed coal a little further S., in the quarry by the roadside, is the bed called the Upper Salem.

DETAILS OF THE SEVERAL COLLIERIES AND MINING LOCALITIES FROM MILL CREEK TO WEST NORWEGIAN.

SECTION ON EAST NORWEGIAN.

The old *Spohn* mine was last worked about twenty-five years ago. The coal had a very gentle S. dip of about 25°, and presented a sudden turn over to a N. dip, which was followed down a short distance from the outcrop. The Spohn Vein was said to be met with on the E. side of the valley, N. of the ravine, where there is an old shaft, now a *well with a windlass.* The coal, shafted at many places just S. of the ravine, is said to be the Little Coal between the Lewis and Spohn Coal. This would be the 3-feet coal found on the W. side of Mill Creek, between the Lewis and Spohn Coals, near Haven's Slope.

The Little Sandrock Coal is obscure on East Norwegian.

The Sandrock Coal crosses the railroad below the solitary white house on the E. side.

The (so-called) *Lewis* Coal of Belmont, or the coal next above the true Lewis Coal, occurs on the road just at the Spring. It is visible in an old drift on the W. side of the railroad.

The *Lewis* Coal is visible in a drift at the railroad; the ventilating-shaft is on it.

A small 2½-feet-thick coal, said to be the Perpendicular Coal of Middle Norwegian, is seen at an old drift; it was cut in the tunnel in Milnes and Synder's Colliery on Mill Creek, N. of the Lewis bed.

The *Spohn* Coal, or supposed Spohn, is at the turn of the carriage-road entering the hollow on the E. side of the railroad.

The *Palmer* Coal is nearer the head of the hollow. Another coal-bed is at the head of the hollow near the house; and still another on the flank of the hill which falls to the S.

There are two coals near the white house—first N. of the hollow—both opened by drifts. The more Northern of these is probably the Charles Pott, and the Southern the Palmer bed.

Near the old Breaker there is an old drift on another small bed.

The *Clarkson* Coal is the next in order, and over it there is another coal with no name; these, at Mr Mason's old mine, are 36 feet apart. It has been thought, from their approaching at their outcrops, that they unite in a folded acute anticlinal: indeed, there is little doubt that this is the place of the axis J. On the N. side of an outcrop of hard sandstone there is a small coal seen in an old drift.

The *Cellar* Coal crosses the road at the first double house at the E. side of the road, and shows a fallen outcrop at the foot of the garden. This is the Stevenson Coal of Mill Creek. The next visible coal is shafted upon at the old house on the E. side of the road, about 100 feet S. of the fork of the road. This dips N. about 40°, under coarse yellow sandstone. A coal crosses at the forks of the road.

The *Chenoweth* Coal is drifted into on the W. side at the S. end of the Delaware Company's old dirt-heap. It lies rather flat.

The *Big Tracey* Coal-drift is at the dirt-heap first S. of the Breaker on the W. side.

The *Little Tracey* Coal-drift is the first N. of the Breaker on the W. side, and appears again on the E. side at the road. This Little Tracey Coal dips under a coarse conglomeritic sandstone, 90 feet N. of an angle of the road, pitching 50° N.

Immediately N. of this rock is the synclinal axis, and then occur S. dips, in which, in the bed of the ravine, is the *Peach Mountain* Coal. The same rock is seen with a S. dip of 40° at an angle of the road on a ridge of the valley of Mill Creek; the Little Tracey Coal-drift is in the basin immediately under it, and its outcrop is on the road 100 feet N. of the turn of the road, and 50 feet N. of the coarse rock.

Jones and Mason's Slope Colliery, at the head of East Norwegian, above Wadesville, has two slopes, one on the N. the other on the S. dip of a saddle in the *Primrose* Coal.

The *North-dipping Slope* is down 40 yards; its average dip is 25°; its average thickness is 4 feet; it has two benches, of 2 feet thickness each; the top and bottom slates are good.

From the bottom of the slope the gangway ran E. about 200 yards. At a short distance from the slope, on the E. and W. gangways, other gangways run N.: their length is not certain. The Primrose Coal is thus seen to saddle at the top of the N. slope, and to basin at the foot.

In the *South-dipping Slope*, which in 1853 was down 108 yards, the dip is 25°, and rather irregular. New gangways were just starting E. and W.

About 500 yards N.W. of the Primrose Slopes there is a slope on the Big or Mammoth Coal, down on the S. dip 155 yards; the dip is about 35°. The coal was about 18 feet thick, and in three benches, with one parting of slate of 3 inches thick. From the bottom of the slope, gangways run E. On the top of the Big Coal lie 7 feet of slate, and on the top of this is the Seven-feet Coal, which is worked on the same slope with the Big Coal. At the foot of its slope is another gangway running E.

S. of the Primrose saddle, in the same hill, is a basin of the Orchard Coals (see Section); and still further S. these form another saddle. It is said that, 300 yards E. of the slope, the Primrose saddle dies away—soon, however, to rise again in nearly the same line.

MIDDLE NORWEGIAN.

North American Company's Mines.—At this colliery the Lewis Coal, one of the more valuable of the Red-Ash series, has long since been wrought out above water-level, and is now mined by a slope and steam-power. The bed is between 7 and 8 feet thick: it dips 30° S. 18° E. About 800 feet N. of the Lewis is the so-called Perpendicular Coal, which is believed by some to be merely the N. dip of the Lewis bed, on the opposite side of the anticlinal axis J; indeed, if I mistake not, they have been proved to connect towards West Norwegian by mining. It is, however, but 3 feet thick at Middle Norwegian, being evidently greatly pinched by the compression of the strata, so usual on the N. side of a steep anticlinal flexure. Nearly 400 feet N. of the outcrop of the Perpendicular Coal is the outcrop of the Spohn bed, which dips 30° S. This coal, believed by some persons to be identical with the Lewis, through the Perpendicular

bed with which it is said to basin below water-level, is about 7½ feet thick. Beneath the Spohn lies the Barclay Coal, 5 feet thick; the Pearson Coal, 3½ feet thick; and the Clarkson Coal, 7 feet thick, all dipping towards the S. at 30° or 35°. To the N. of the anticlinal axis I, these coals reappear in the Peach Mountain Basin, but under the different names already mentioned.

WEST NORWEGIAN.

The Pea-conglomerate N. of the *Diamond* Coal of West Norwegian is certainly like the conglomerate beneath the Big Diamond Coal of Silver Creek, Zachariah's Run, &c., and I regard it as the same rock. It is seen in the point of a hill or spur N. of the Old Diamond Slope chimney, West Norwegian.

The dense Pea-conglomerate, visible at Mount Laffy under the Primrose Coal, is to be seen again on West Branch, just N. of Morgan Brace's Breaker. There can be no doubt that Morgan's Coal of West Branch is identical with the Primrose of West Norwegian, Mill Creek, &c. It seems most probable that the main anticlinal of Mount Laffy is that of the Oak Hill Coal of West Branch.

Charles Miller's Slope on Mine Hill.—Down on the bottom-slate of the Mammoth or Big Coal, the S. dip averages 55°. The Big Coal is 6 feet thick; immediately on the top of this is a very hard rock, from 3 to 6 feet thick, then a 7-feet coal, then 7 feet thickness of slate and rock, to a 12-feet coal called the Seven-feet Coal, the same as the Black Heath of Heilner's Tunnel, all worked by a slope. (Though this is the slope referred to in our notes on East Norwegian, derived from Mr Davis, in some points the statements disagree.)

Mount Laffy Tunnel enters N. into Mine Hill; the length of breast in the Big Coal is 60 yards, the dip of the beds is about 45°, but it becomes flatter in going N.

Brown's Colliery.—The *Primrose* Coal has been actually traced hence W. about 1100 yards; this would be nearly to the swamp. It has been worked on the upper level that distance, and the air-holes may be followed nearly to the swamp. The average thickness of the coal is 9 feet. When sound, it has eight benches. In its lower part occur 3 feet of *Red-Ash* Coal, which, when not pure and sound, is all dirt; above this there is a 15-inch layer of bony coal, and over this are six benches of Pink-Ash coal. The two, mixed, make a good Red-Ash coal.

The N. and S. dips of the Primrose Coal, at the water-level, are about 150 feet apart, but at the road-level, 60 feet higher, they come together. The N. pitch at water-level is 80°, the S. pitch 40°. The Orchard coals overlie the Primrose on the axis, at an interval of 140 to 150 feet, and back from the valley on both sides are saddled over by the conglomerate. The axis of the Primrose flattens towards both the E. and W.; towards the W. it disappears in about 400 yards, but it continues a greater distance Eastward. It is cut just at the mouth of the Mount Laffy Tunnel. Below the Peach Orchard Coal there is a slaty floor of 18 inches thickness, and below this 12 feet of hard blue sandstone, and below this again 40 feet of slate, including two courses of iron ore. Underneath these there is a bed of massive ore locally 18 inches thick, next slaty rocks, hard and blue, 30 feet, and then solid blue sandstone 12 feet thick, and finally, the slate above the Primrose. Over the Orchard is first fireclay, then slate with sulphuret of iron, then a little blue and ochreous slate. The distance between the two

Orchard coals is 45 feet. The lower Orchard bed extends, at a pretty steep pitch, to about 50 feet below water-level. The dip of the rocks in Brown's Shaft is about 24° S. The N. dips of the Orchard Coal come in N. of the ravine opposite the shaft. The North Diamond forms a basin, in the centre of which stands Mr Brown's house, just at the level of the turn.

The Big or Cockle Diamond is a somewhat bony but good coal, 7 feet thick; it is worked at Miller's Phœnix Slope, on West-West Branch.

The true Little Diamond (if correctly identified) is worked under Spencer's Breaker, near Minersville, also on Wolf Creek, and on West Norwegian, where there are from 2½ to 3 feet of good coal in it.

Peach Mountain Coal of West Norwegian—(Delaware Mines).—The upper slope in 1853 was sunk about 200 yards. The coal had been worked Westward from the Old Slope one mile, and from the New Slope 90 yards more. At the New Slope the bed dips S. from it at an angle of 45°, then more steeply; and still deeper down it flattens off to 45° again.

The basin is thought to descend gently Eastward. At the East Mines, on the contrary, the basin descends towards the W., as the dimensions of the trough opposite the two slopes there clearly prove. In the one, the length of slope to the synclinal turn or bottom of the basin is only 150 feet; in the other, 400 yards further W., with a somewhat more gentle dip, it is 300 feet, the North-dipping branch of the bed being about 70 feet. The distance between the N. and S. outcrops of the Peach Mountain Coal, 1000 yards W. at the railroad, is one-fourth of a mile.

The Peach Mountain Coal on the S. side of the basin, or the North-dipping perpendicular outcrop, has been worked more than 700 yards E. from the West Norwegian Railroad by Mr Reed. It is 300 yards from the North-dipping Spohn to the last-dipping Peach Mountain. There is no coal of any importance between them. At the turnpike, the Spohn is 150 yards from the North-dipping Peach Mountain.

The coal at the slope is the *Dill*, the upper bench of which is from 4 to 6 feet thick, whilst below this is a hard slate, of from 6 inches to as many feet in thickness, and beneath this an inferior coal from 2 to 3½ feet thick. At the E. mines, these parting-slates varied rapidly in the same gangway, thinning away to nothing, and then again being many feet in thickness. The coal of the S. dip is much better than that of the N. dip. The Dill Coal is not 100 feet N. of the Peach Mountain gentle S. dip.

George Miller's Works.—A perpendicular *shaft* is here sunk to the *Lewis* Coal, the 85 yards descent giving a lift of 140 yards to the old water-level of the coal, and 30 yards more to the outcrop, which is on the brow of the hill to the Northward. The dip of the Lewis is from 31° to 32° S., and regular; its average thickness is 6 feet. From the valley a tunnel runs N. under the end of the hill about 350 yards to the Lewis Coal. This coal lies in three benches: the bottom one has 2½ feet of clear prime coal; the middle a band of slate from 2 to 9 inches thick, and a coal one foot thick; and the upper bench 2½ feet of coal, with a parting of shelly coal.

The pillars were being worked out in 1853. The coal had been worked both above and below water-level from this shaft 600 yards E., and up to the line of the North American Company. Above the coal lies a bed of slate 15 feet thick, and then a considerable thickness of soft grey and greenish sandstone-ore, weathering ochreous, and passing at times into argillaceous shaly sandstone. From the bottom of the shaft there descends a slope on the coal 100

yards deep. The seam is cut off on the E., about 200 yards from the bottom of the shaft, by a rock-fault. The gangway near this turns a little towards the N., about 10 yards in 100. The plane of the dislocation runs a little E. of N., and dips towards the N. at about 85°. Beyond the W. limit of the tract the coal is again cut off by a rock-fault. The Lewis Coal, although sought for, has not been proved on the W. side of the West Norwegian Valley.

The Spohn Coal, which has been wrought a short distance N. of the Lewis with like dip, is also cut off by the fault first mentioned, and has not been traced to the opposite side of the valley.

The following is a detailed section of the Coal-measures in the Sharp Mountain, commencing from the top of the main Seral conglomerate, the horizon of which is, however, rather arbitrary.

SHARP MOUNTAIN COAL-MEASURES, POTTSVILLE.

(See General Section, Plate II.)

No.		Thickness. Feet.	In.
1.	The first belt of coarse conglomerate beneath the lowest coal; pebbles, chiefly quartz, many of them as large as a hen's egg,	17½	0
2.	A grey conglomeritic coarse sandstone,	8	0
3.	A coarse grey argillaceous grit, with specks of coaly matter and impressions of coal-plants,	1	7
4.	Grey silicious sandstone,	6	5
5.	Micaceous and slightly argillaceous flaggy sandstone, with some conglomerate,	4	0
6.	Coarse grit, irregularly laminated,	8	0
	Hiatus. An absence of definite outcrops from the foregoing stratum to the Plumbago Coal, but the fragmentary matters indicate coal-shales, and probably a thin and soft bed of coal,	139	0
7.	*Plumbago Coal*, 1.—This coal, as already intimated, is much crushed, and therefore but little reliance can be placed upon any local measurement of its size. A lump of the coal crumbles under slight pressure into thin glossy flakes, having an unctuous feel, and a lustre resembling that of plumbago. An argillaceous bed S. of the coal—its original fireclay floor—is generally in a crushed condition. The shaly matter is mingled with finely-comminuted coal, and resembles the substitute for plumbago called *Blackpot*,	7	0
8.	A dark laminated sandy top-slate, with coal fo ils; it is much fractured,	19	6
9.	A bluish argillaceous shale, but little laminated,	35	6
10.	A bottom-slate on sandy fireclay, like No. 9,	5	0
11.	*Coal* 2.—Crushed and soft,	1	6
12.	A top-slate,	4	0
13.	Bluish shale, approaching a fireclay,	12	0
14.	Hard grey sandstone,	6	0
15.	*Coal* 3.—A coal, and its thin bottom-shale crushed together,	2	6
16.	A thin bed of roof-slate.	—	
17.	Blue argillaceous shale, or under-clay of coal,	15	6
18.	*Coal* 4.—A coal-bed,	7	0
19.	The roof-slate of Coal 4,	2	6
20.	Coarse micaceous sandstone, slightly argillaceous,	21	0
21.	Hard grey gritty sandstone,	65	0
22.	Blue shale, soft and crushed,	2	6
23.	*Coal* 5.—A soft crushed coal-bed, containing a little sound coal in its middle layer,	7	0
24.	Compact blue slate and shale,	56	0
25.	Coal shale, with impressions of Stigmaria,	2	0
26.	*Coal* 6.—A coal-bed,	2	0
27.	Slate, blue and compact,	10	0
28.	Shale, soft, crushed, and shivery,	10	0
29.	Hard blue argillaceous sandstone,	62	6
30.	Alternation of beds of sandstone and slate,	30	0
31.	Coarse blue argillaceous grit,	15	0
32.	Carbonaceous slate,	20	0
33.	Bluish coaly slate,	7	0
34.	Coal shale,	4	0
35.	*Coal* 7.—Coal and bruised shale mingled,	15	0

No.		Thickness. Feet.	In.
36.	Black slate,	4	0
37.	Obliquely laminated argillaceous sandstone,	4	0
38.	Blue and grey argillaceous grit,	10	0
39.	Fine-grained blue sandstone,	13	0
40.	Shale, soft and contorted,	9	0
41.	*Coal* 8.—A coal-bed, crushed and soft,	1	0
42.	Laminated dark-blue roof-slate,	9	0
43.	*Coal* 9.—A coal-bed,	1	0
44.	Fine-grained argillaceous sandstone,	76	0
45.	No distinct exposure,	9	0
46.	Grey ferruginous sandstone,	5	0
47.	Blue coal-shale, sandy fireclay,	8	0
48.	*Coal* 10.—A coal-bed, not in a sound condition,	16	0
49.	Dark roof-slate, with fossil ferns, &c.,	1	0
50.	Coarse blue argillaceous sandstone,	10	0
51.	Blue shale and slate,	2	0
52.	Micaceous sandstone,	14	0
53.	A more argillaceous micaceous sandstone,	30	0
54.	Argillaceous, arenaceous, and micaceous sandstones,	51	0
55.	Coarse grey sandstone,	2	0
56.	*Coal* 11.—Coal and shale; the thickness of the coal-bed itself not ascertained, both	? 24	0
57.	Shale, with Calamites,	20	0
58.	Coarse grey sandstone,	4	6
59.	Alternation of shale and sandstone,	8	0
60.	Argillaceous grey sandstone,	4	6
61.	Grey sandstone,	16	0
62.	Shale and sandstone,	15	0
63.	Coarse arenaceous sandstone,	30	0
64.	Greenish shale,	4	0
65.	Greenish argillaceous sandstone,	9	0
66.	Grey and greenish grit,	10	0
67.	Coarse argillaceous sandstone,	8	0
68.	Conglomerate and coarse grit, with argillaceous cement,	19	0
69.	Olive-coloured slate,	4	0
70.	Coarse argillaceous sandstone,	12	0
71.	Blue slate,	1	0
72.	Grey shale and slate,	28	0
73.	Coarse argillaceous sandstone,	5	0
74.	Fine-grained argillaceous sandstone, *much crushed*. Great synclinal axis or line of change of dip, marking the deepest part of the Sharp Mountain Basin. Here the strata change from their steep inverted dip of 85° near the axis, to a moderately gentle Southern dip at the base of the mountain, just behind Silver's Houses, or opposite the E. and W. reach of the Schuylkill.		

Where an attempt is made to recognise the particular coals of this Pottsville group at the other natural transverse sections of the Sharp Mountain, it is found impossible to identify more than a portion of them. This arises from the circumstance that their overturned and shattered condition has prevented their being extensively opened at any of the other localities between this spot and Tamaqua on the one hand, and the Swatara Notch on the other, and from the fact that, even in the vicinity of Pottsville, they have not, from the same cause, been followed far enough along their outcrops by experimental shafting, to permit us to trace them continuously to their other exposures.

An examination of the Section above given of the Coal-measures of the Sharp Mountain discloses only eleven coal-beds of all dimensions, from a thickness of from 1 to 15 feet. As this is just one-half the number of the seams separately identified and mined on Mill Creek, distant only from 2 to 4 miles, we are compelled to infer, that from the squeezed and faulty condition of the strata in the flank and at the base of Sharp Mountain, between Mount Carbon and Pottsville, some of the beds have never been detected. It is probable, indeed, that a few of them are lost entirely at the surface in the one or more longitudinal dislocations, of which there are strong indications between the synclinal axis of the basin and the side of the mountain. That this S. side of the basin does actually contain more than the eleven coals discovered at Potts-

ville, is implied by the fact that the Randolph Tunnel further E. in Sharp Mountain, entering some distance to the S. of the synclinal axis, cuts itself no less than ten notable coal-seams. If I mistake not, there are at least fourteen beds recognisable between the base and upper slope of the mountain S. of Port Carbon. In a future chapter, devoted to a general comparative survey of the coal-beds of the basin, it will appear that the district of Mill Creek contains a greater total number of separate beds than any other.

COALS IN THE NORTH SIDE OF THE SHARP MOUNTAIN BASIN.

Between the folded anticlinal flexure of Gate Ridge and the synclinal bend of the Sharp Mountain Basin at the Schuylkill, the stratification is very regular from Mill Creek Valley to that of the Norwegian at Pottsville; the dip is uniformly S. as steep as 45° near the anticlinal axis, but gradually subsides to 35° and 30°, as we approach the middle of the trough. The total number of coal-beds is thirteen, eleven of which have names; these in ascending order, or Southward from the Gate axis, are—1. The Alfred Lawton; 2. Belfast; 3. Selkirk; 4. Black Mine; 5. Tunnel; 6. Rabbit Hole; 7. Faust; 8. North Salem; 9. Weasel; 10. Salem; 11. South Salem. Their dips, distances, and thicknesses are given in the Sections. The accompanying cut

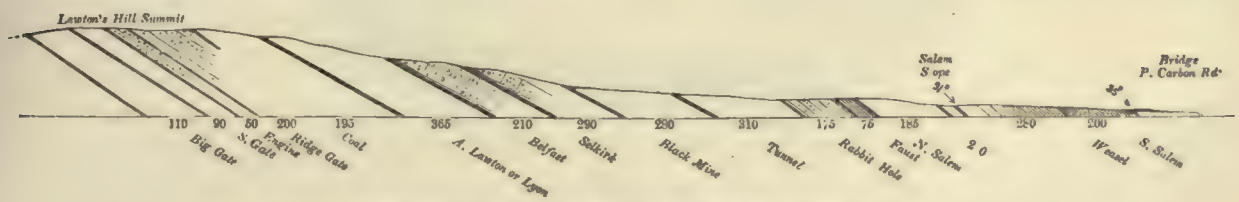


FIG. 171.—Section of Salem Hollow, looking E.—1 *inch* = 400 *feet.*

represents the state of things along a line of section between the summit of Lawton's Hill or Gate Ridge and the Schuylkill through the ravine called Salem Hollow, a little E. of Pottsville.

Plate II. of the Sections of the Anthracite Basins represents these coal-beds as they are seen at Pottsville, on the E. side of the Norwegian Valley, from the N. foot of the Gate Ridge to the synclinal axis; and another Section on the same Plate displays their positions on the other side of Salem Hollow, opposite the valley of the East Norwegian. A correct view of the end of the Gate Ridge on the E. side of the valley at Pottsville is given in our woodcut (fig. 172). A little dimple or depression in the face of the hill shows the superior force of the excavating waters upon the crushed strata immediately at the anticlinal axis; the light dotted lines indicate the dips of the coal-beds on the two sides of this oblique saddle. (See Section of Gate Ridge.)

At Pott's Colliery, west of Pottsville, the distance from the Tunnel Coal to the Rabbit Hole bed is 60 yards, from the Rabbit Hole to the Faust it is 40 yards, and from the Faust to the Salem it is 95 yards. These horizontal measurements disagree widely with those of the corresponding strata at Salem Hollow. The discrepancy is due in part to a difference of inclination, but in a yet greater degree to an actual change in thickness of the dividing rocks, especially the sandstones.

Salem Colliery, Salem Hollow, East of Pottsville.—This mine in the Salem Vein is interesting

as being the deepest slope working in the coal region, and as belonging, moreover, to the uppermost of all the workable seams. In 1853 the length of the slope was 1030 feet; the average angle of dip is S. 35°. At that time there were five lifts, and at the foot of the slope the E. gangway was 200 yards long, and the W. gangway 150 yards. The other lifts, or intervals between gangway and gangway, had been mined E. to the Port-Carbon Salem Colliery, and W. beyond Pottsville. This coal-seam exhibits a thickness of from 2 to 3 feet, but it is variable: the coal is usually in one bench, and beneath it is a seam of soft powdery coal (or dirt) one foot thick. The slope descends in a direction S. 20° E., and the bottom of it is vertically under the river.

Fig. 172.—End View of Gate Ridge (Lawton's Hill), Pottsville, looking E.

CHAPTER VIII.

ANTICLINAL FLEXURES OF THE COAL-FIELD BETWEEN WEST NORWEGIAN AND SWATARA VALLEYS TRACED IN DETAIL, WITH THE COAL-BEDS ALONG THEIR AXES.

AXIS OF SWATARA FALLS AND PRIMROSE HILL, OR ANTICLINAL M.

The most Northern clearly-traced anticlinal of the W. part of the Pottsville Coal-field is that of the Swatara Falls, where the flexure elevates the Lower Great Conglomerate of our Coal-measures. There is another axis, L, of Broad Mountain, still further N., but it is too little known to merit a more detailed description than that which it has already received. That of the Falls is a well-marked axis, having steep N. and comparatively gentle S. dips, and is plainly marked in the topography of the country by the crest of the ridge prolonged from the Swatara eastward, as far as the valley of Muddy Creek.

Traced through the high crest alluded to, it gradually sinks until we descend into Muddy Creek Hollow, where the anticlinal passes some hundred yards S. of Morgan's Tunnel.

Still Eastward from this, an anticlinal, either the same one prolonged or another replacing it, and nearly continuous with it, ranges a little S. of the mouth of the York Tunnel. This may be traced to West-West Branch, where it is seen as a low and narrow arch, affecting the Little Diamond and adjoining coals of Patton's Valley near Britton's Store, from whence it passes through the N. part of Primrose Hill, being the Northern of the two flexures which turn the Peach Mountain (Kantner) Coal in M^c^Donald's Colliery, and there indicated by the N. ventilating-stack.

Traced Westward, it will be found to cross the ravine of Middle Creek N. of the W. head of Fisher's Basin. Rising and separating the conglomerate which saddles it into two outcrops, it at last lifts to the surface, high on the S.W. plateau of the Broad Mountain, the upper beds of the Umbral red shale.

Turning our attention to the strata exposed on the back of this great saddle at the water-level of the main transverse valleys, we find that in the gorge of Middle Creek it lifts to the day the lowest main bed of Egg-conglomerate, and even some of the inferior conglomeritic strata.

On Swatara, the whole upper half of the Seral conglomerate, embracing both the upper and lower main Egg-conglomerates, and a small coal between them, rises above the water-level in the centre of the finely-exposed arch.

At the valley of Muddy Branch, the White-Ash Coal, so called (Bast's White-Ash Vein), comes down to the water-level, closing its two outcrops together to arch over it, or lap across it. Just E. of this point, the Grey Ash, or next superior coal, in like manner sinks under the water-level, and its gangways wind round the axis from S. into N. dips.

Still further E., at a point a few hundred feet E. of the York Tunnel, it deflects or winds the gangway of the Big Diamond Coal worked in from the water-level of the West-West Branch, from its place on the N. dip of the basin S. of it, to a position on the N. dip of the basin N.

Dipping very gradually E. towards the West-West Branch, the axis there allows the Little Diamond and two subjacent coals, previously on its flanks, to fold or arch across it at the water-level of the valley near Britton's Store. (See West-West Branch Section.) As the more Northern of the two adjacent saddles in the Kantner Peach Mountain Coal of Primrose Hill, this axis is discernible in the windings it gives to the gangways of that coal the whole way as far as the valley of Wolf Creek, where it probably affects the South-dipping portion called the Spencer Vein, in a low roll a little S. of the foot of Spencer's Slope. It is visible, indeed, in a narrow space of N. dips on the road from Minersville, leading along the E. side of Wolf Creek Valley. It seems to expire altogether before reaching the valley of West Branch.

At the West-West Branch this anticlinal axis lifts the Big Diamond Coal, on the W. side of the valley above the water-level, but it does not bring it quite to that elevation on the E. It is there the main anticlinal of the broad swell of Primrose Hill, and where this hill assumes its height E. of the valley, it contains on the back of this saddle, in unbroken concentric arching, all the Coal-measures between the Big Diamond under water-level, and the Cockle's Red-Ash or Oak-Hill Coal of Wolf Creek (the Peacock of Mill Creek?) This Cockle's Red-Ash Vein, the highest which completely arches the axis, has been here mined entirely across it in Britton's workings. The Little Diamond, which is two coals higher in the series, does not saddle it in the

hill, but is parted into two outcrops. The Cockle's Red-Ash Coal is that of the N. or New Slope of the Phœnix Mines, while the Little Diamond is the coal of the S. or Old Slope, but between the anticlinal now described and these outcrops of the slopes there is interposed another axis, N, to be traced presently.

Advancing Eastward from West-West Branch, the axis continuously sinking, and the hill still swelling in height, we find that the Little Diamond Coal soon rolls over the arch. Further on, when we ascend to the summit of Primrose Hill, even the Peach Mountain or Kantner Coal unites its outcrops, and laps across and round the axis. This is near the little village of Primrose Hill. This axis is the main anticlinal, that previously described being but a roll on its N. flank. They are closely approximated, and are of nearly equal force, so that they impart a double undulation to the strata, the effect of which upon the working of the mines, in the Peach Mountain Vein, is to turn its gangways, at the different successive levels, in a double or arcuated winding course, sweeping from S.E. into E. dips, and finally into N. dips. This axis and its companion form the quite feeble arch in the rocks just S. of the Spencer outcrop of the Peach Mountain Coal, visible on the road on the E. side of Wolf Creek Valley; beyond that point neither of them is discernible.

AXIS OF THE DRIPPING ARCH AND PHŒNIX MINES, OR ANTICLINAL N.

In the W. quarter of the coal-field, the next more Southern anticlinal first indicates itself on Middle Creek of Swatara, forming there the S. boundary of the W. end of Fisher's Basin. The exact position of this axis is the bold and picturesque arch of the upper Egg-conglomerate at the Dripping Spring. Here the flexure is a very gentle one, the N. dips of the S. side of Fisher's Basin here not exceeding 10°. In ranging Eastward the anticlinal develops itself into a bolder flexure, with steeper inclinations on its flanks.

The maximum compression of the wave appears to be in the neighbourhood of Muddy Branch at the Heckscher New Mines, where the N. dips amount to 75° and the S. to 30°. From this point Eastward, still slowly dipping in level, the saddle gradually flattens, but the N. dips connected with it do not disappear; or, in other words, the axis does not cease until we reach the West Norwegian.

Westward from Middle Creek it is not traceable in distinct N. dips for any considerable distance, but its influence is felt in spreading wider the flat or gently Southerly dip of the strata, and in expanding the S. slope of Thick Mountain, N. of Donaldson, into a broad elevated plateau. This flattening of the anticlinal lifts and smooths out of course the synclinal flexure of Fisher's Basin, which soon ceases altogether before reaching the meridian of Donaldson, but is replaced in the same range by moderate S. dips of from 15° to 20°, all across the mountain.

The effect on the Coal-measures of this axis, tracing it progressively Eastward, is, at Middle Creek, to place the upper layers of the great upper Egg-conglomerate, supporting the lowest workable White-Ash coals, the Ten-feet Vein, so called, &c., at an elevation of about 100 feet above the stream in the bottom of the gorge.

On Swatara this arch appears with maximum dips of about 45°, separating Fisher's from M'Creary's Basin, and it there divides by several hundred feet the two outcrops of the Grey-Ash coal, the lowest vein which is worked. Between the denuded back or top of the arch and

the water-level of the valley, only the coarse sandstones and Pea-conglomerate beds, just over the main upper Egg-conglomerate, are exposed through a height of some two hundred feet, but the Egg-conglomerate itself does not quite rise to the bed of the valley. (See Section on Swatara.)

At the valley of Muddy Branch the Heckscher Red-Ash Coal is parted at the water-level into two outcrops several hundred feet asunder, but the Grey-Ash, or next subjacent coal, does not reach the surface of the valley. It is not easy to trace this axis by actual exposures to the Eastward of Muddy Branch, for as yet no North-dipping strata have been discovered in the line of its prolongation until we reach the West-West Branch. It, however, corresponds so closely in position with the anticlinal of the Phœnix Mines on that stream, or with the Peach Mountain and Kantner axis, north of Minersville, that I am disposed to look upon them as one identical line of flexure. This last-mentioned E. division extends with apparent continuity from the West-West Branch to the West Norwegian at the Green Park Tunnel.

To recapitulate the chief facts known respecting this axis, it may be briefly described as that of the Phœnix Tunnel and of Heckscher's Red-Ash Colliery. At Minersville it lifts to the water-level the Little Tracey Coal, and it parts the Kantner and Peach Mountain coals. At the Phœnix Tunnel it carries over it at water-level the Phœnix North-Slope Coal, or Cockle Red-Ash, or Mill-Creek Peacock Coal. On the W. side of West-West Branch it has lifted above water-level the Bast Big Diamond, or Phœnix North Coal, and Phœnix South Coal. At Muddy Branch (Otto Lands) the Heckscher Red-Ash Coal is parted into two high outcrops by it. On the Swatara it lifts to water-level the sandstones overlying the upper main Egg-conglomerate, sustaining in two sets of outcrops, high on the flanks of the saddle, the three lower coals of Fisher's Basin and McCreary's S. dips : viz., the Grey Coal, the Ten-feet Donaldson, and Donaldson Big Coals. At Middle Creek it elevates to 100 (?) feet above the water-level the top beds of the great upper Egg-conglomerate, saddled there by the same coals above mentioned. But at Donaldson Mines in Thick Mountain this anticlinal is no longer seen, the basin N. of it having been lifted or flattened up, and indeed replaced, by gentle S. dips, varying from 15° to 20° S. all across the mountain.

BASIN *M N*, SOUTH OF SWATARA FALLS AXIS — PART OF FISHER'S BASIN.

On the Swatara, and for some distance Westward, as far at least as Middle Creek, this basin still retains above the upper Egg-conglomerate three several coals, the two higher of which are valuable beds for mining. The bottom or synclinal centre of this basin seems to rise going Westward for a certain distance, and then to descend again towards Middle Creek, falling there to a level only a little higher than that which it has on the Swatara. The probability is, that it is highest somewhere near the watershed between these streams.

Recent explorations make it almost certain that none of these coals above the upper great Egg-conglomerate pass Westward in this basin beyond the ravine of Middle Creek ; but a lower series of White-Ash seams, five in number, have been opened on the S. side of the Swatara Falls anticlinal, or N. side of this trough, on the flank of the mountain, at a point considerably to the Westward. How far these extend is not yet known, but the sandstone measures of the flat summit of the Thick Mountain, N. of Donaldson Mines, give but little indication of their

presence there. Of the five coals here spoken of, the two lower ones are each of them but 6 inches thick ; the third appears to be in the shafts on its outcrop, about 7 feet in thickness ; the fourth is 6 feet thick, but contains very little good coal ; and the fifth, or highest, is 2½ feet thick of coal, rather squeezed and soft ; there is a conglomerate rock both above and below this latter, but its outcrop is some 600 feet N. of the main upper conglomerate, or " Big Rock." The dip in all of them is about 30° S.

Middle Creek.—It would appear that the upper large White-Ash coals lying above the upper main Egg-conglomerate—namely, the Donaldson "Ten-feet" and "Big" Coals, do not extend W. of the gorge of Middle Creek, or of the parallel of the Dripping Spring " Big Rock" in the Fisher's Basin, having been there washed out from this deeply-excavated portion of it. But on the E. side of the stream both of these coals, and one other, have been opened, dipping gently both N. and S. from the anticlinal axis.

1. The lowest or first of these is the little " Grey Vein." This is shafted on near the very centre of the trough.

2. The Donaldson Ten-feet Coal is here entered by a gangway near the synclinal axis, the dip being 19° N. At this spot the coal is soft and faulty in the gangway.

3. The Donaldson " Big Vein " or " Lomason" Coal has likewise been shafted on and identified. In this place this coal is not capped by the thin bed of coarse Egg-conglomerate, which is so distinguishing a feature of it at the Swatara, and in the Otto Tunnel (Morgan's).

At this pass of Middle Creek through the basin, the " Grey Vein," or the first above the " Big Rock," lies just at the level of the stream ; the next, or Donaldson (Ten-feet) Coal, about 50 or 60 feet above it, and the upper or " Big Coal" 80 or 90 feet.

Swatara Creek.—At the fine natural section through the basin made by the valley of Swatara Creek, the same three coals above the upper Egg-conglomerate lie above the water-level, as already intimated. The two uppermost of these, the locally so-called Grey-Ash and Red-Ash coals, or the Donaldson Ten-feet and Big Vein, are there successfully mined. The lowest of the three, the Little Grey-Ash Vein, has been shafted on and " proved," but is not mined. It is 4 feet thick, and is good coal.

Though the N. dips from the Dripping Spring anticlinal, or South-bounding axis of this basin, are, at their steepest, even as much as 40°, the S. dips from the Swatara Falls anticlinal are at a much lower angle ; and this general flatness of the measures, combined with the quite high elevation of the ground between the Swatara and Middle Creek, causes the two outcrops of even the highest of these coals—the Big Vein or Red-Ash coal—to recede quite far apart. Where they attain the watershed which separates these streams, they are probably from 1500 to 1800 feet asunder.

On the W. side of the Swatara, where the two upper coals now spoken of were mined by D. Brown & Co. (1852), the main and upper Grey-Ash bed (the Ten-feet Vein of Donaldson) basins about 80 feet above the water-level of the valley, and spreads its outcrops in this deeply-trenched hill-side, about 800 feet apart. This bed does not here saddle the axis S. of it, but, rising out in a N. dip, comes in again on the S. flank of that anticlinal, where it is known as McCreary's Grey-Ash Vein. Though called at Donaldson the Ten-feet Coal, such is really not its usual size, and in the locality now before us its true thickness is about 5 feet ; but the coal is good. It yields on combustion a *grey ash.*

Black Valley Coal.—The upper or Red-Ash coal of this locality (Donaldson Big Vein and Forestville, or Black Valley Coal of more Eastern sections) lies at the Swatara, about 40 feet above the Grey-Ash coal, and of course fills a narrower basin. Its average thickness here is about 10 feet, and it yields of good coal some 7 feet. This coal affords a *pinkish* ash, or rather the upper bench or layer is pinkish, and the lower Red Ash. Neither of these beds had, in 1852, been extensively mined, their longest gangways being about 300 yards. Immediately over the Red-Ash bed there rests a rather remarkable roof-rock in the form of a coarse Egg-conglomerate, composed of the usual pebbles of quartz and white and grey sandstone. It varies in thickness from 10 to 6 feet, and is overlaid by the ordinary shale and coarse sandstone. It is an admirable guide to this coal, and though it does not retain its distinctive coarseness E. as far as Forestville, or W. to Middle Creek, yet it holds it as far as the Muddy Branch, and has there enabled me, in the Otto Tunnel (Morgan's), to recognise the coal-bed N. of it as the equivalent of this Red-Ash seam of Swatara, or the Big Coal of Donaldson. So coarse a mass of gravel strewed over the coal, and confined to so local a distribution Eastward and Westward, implies an unusual force and narrowness in the current which swept it in upon the surface of the broad marsh or peat-bog in which the coal-bed originated.

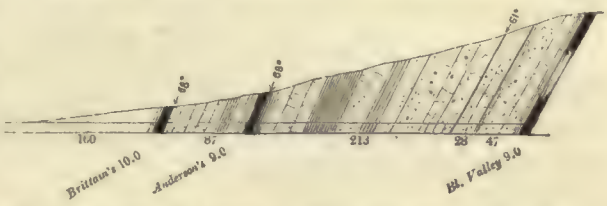


FIG. 173.—Morgan and Edward's Tunnel, Otto Tract, looking East.—1 *inch* = 200 *feet.*

WESTERN GROUP OF THE SUBORDINATE ANTICLINALS OF THE CENTRE OF THE COAL-FIELD, BETWEEN WEST BRANCH AND SWATARA.

Some of this group of subordinate anticlinals of the Peach Mountain belt, the most Western of this disturbed zone, range as far as the Swatara, between which and the valley of West Branch I shall now proceed to define and trace them in detail as far as their obscurity will allow. A few at least of these axes are probably not continuous throughout this length of country, but are disposed towards each other in a slightly oblique arrangement—such that, if prolonged in straight lines, they would pass each other, turning, in certain instances at least, into one another by a transverse warping and change of strike in the strata. Bearing in mind this feature, we may regard these chains of anticlinals, thus intimately linked, as truly continuous waves separating more or less continuous basins.

PEACH MOUNTAIN KANTNER AXIS, OR ANTICLINAL N.

The most Northern, and one of the best defined, as respects the district before us, of this belt of anticlinals, is that which I propose to name the Peach Mountain Kantner Axis.

This anticlinal, to which allusion has been already made as that forming the S. dips of the two Phœnix Slopes, though important in its influence on the strata in the district between Muddy Branch and Minersville, is, in its Western extension between West-West Branch and Muddy Branch, somewhat obscure. It has its maximum development between West-West Branch and Minersville. In the first of these localities it presents itself as a narrow and rather sharp axis, the summit of which is a short distance N. of the Northern Phœnix Slope. It passes through the Phœnix Tunnel, and in this neighbourhood lifts the coals into N. dips of about 50°,

and S. ones of 35°. The road from Phœnix Mines over to Minersville follows very nearly parallel with this anticlinal. It passes through Minersville, crossing the valley of Wolf Creek about 500 feet S. of Heilner's Colliery on the Kantner Coal, and thence across towards West Branch through the spur or hill dividing these valleys, appearing on the road leading N. from Minersville, about a quarter of a mile above the main street of the village, at a depression, near which both its N. and S. dips are discernible. It crosses the flats of West Branch 1000 feet N. of the slope colliery of Wagner's Tunnel, and produces the S. dips of the strata near the tunnel's mouth. Further Eastward than this it is difficult so precisely to define its position; but in all probability it is the axis which, on West Norwegian, lies S. of the tunnel, entering at the so-called Green Park Vein.

Westward from West-West Branch it ranges to Muddy Branch, and thence to Swatara at McCreary's Mines. The most W. point to which it may be *continuously* traced from Minersville is on the crown of the ridge which contains the so-called South Mines of the Phœnix Company, where the very place of the axis is marked by the air-holes of the South-dipping vein of this mine. It pursues nearly the crest of this ridge to the head of the ravine which opens S. into Muddy Branch at Weaver's.

Adverting now to the lowest coals which lap over this anticlinal at the water-levels of the valleys which intersect it, we find that on the E. side of the West-West Branch it just lifts above the water-level the higher of the three small coals which lie between the Big Diamond and Cockle's Red-Ash seams. This last-named coal, worked below the water-level in the Phœnix New Slope, and above from the Phœnix Tunnel, has been followed in mining continuously over the anticlinal arch into its N. dips in Britton's Basin. (See West-West Branch Section.)

Further E., by the dipping of the axis (?), and the rise of the country to the watershed dividing the West-West Branch from Wolf Creek Valley, higher coals fold over the anticlinal, until near this watershed, on the Minersville Road, the two converging outcrops of the Peach Mountain Coal—that called the Kantner running to Heilner's Colliery, and that called the Peach Mountain traceable and mined into Minersville at the Catholic chapel—approach each other towards its summit to within about 150 feet of each other. The soft shales and argillaceous strata underlying this Peach Mountain Coal have permitted an extensive denudation on the back of this axis, from the watershed just mentioned, Westward into West-West Branch, and Eastward into the valley of Wolf Creek, the effect of which is to throw apart the two outcrops of this upper coal further and further in both directions.

MINERSVILLE CENTRAL AXIS, OR ANTICINAL O.

South of the Peach Mountain Kantner Axis, and in nearly strict parallelism with it, is another, which I have called the Minersville Central Axis, from its passing through that town. This cannot, in the present state of the developments, be traced with precision E. of the valley of West Branch, though it is very possible that one of the Peach Mountain anticlinal folds of West Norwegian may be identical with it. Either as a continuous anticlinal, or a chain of proximately connected short axes, this line of saddle is traceable nearly as far W. as the West-West Branch. For the district of West Branch it would seem to have its greatest elevation and closest compression in the vicinity of Minersville. In its range immediately N. of the Miners-

ville or Lewis's Tunnel, it brings just to the water-level the coal-bed next beneath the Peach Mountain Vein ; whereas on the West-West Branch it lifts to the day only the Peach Mountain Coal itself, here called the Fire Vein.

MINERSVILLE SOUTH OR PEACH MOUNTAIN INVERTING AXIS, OR ANTICLINAL O.

The anticlinal axis just Southward of the town of Minersville ranges across the West-West Branch, where it arches the Peach Mountain Vein above the water-level. The ground is naturally so obscure, and has been so imperfectly mined, that there is some doubt whether the West-West Branch axis is really this one or that previously described—namely, the axis O just N. of the mouth of the Old Tunnel. That the Southern axis is a flexure with inversion, is shown by the fact, that the two interior or Southern coals of the Old Minersville Tunnel, though dipping S., are identical with the two exterior ones, proving that a compressed synclinal ranges through the tunnel. A little further S. in the measures we meet only with uninverted N. and moderate S. dips. These last are exposed on the Minersville and Llewellyn Road.

The coals in the Old Minersville Tunnel (Lewis's) are the Peach Mountain and the vein next overlying it. Each of these, by the inverted fold, is twice produced, so that the tunnel seems to intersect four. In mining the Peach Mountain Vein westward from this tunnel, Mr George Spencer found the inversion of the S. side of the synclinal to continue for nearly half a mile, beyond which the coal became too faulty to be followed. In the same direction from the tunnel, the other or uninverted limb of the Peach Mountain Vein was found, after running parallel for several hundred yards, to recede to the Northward, its S. dip, which before was about 30°, growing flatter as the outcrop trended more and more to the N. of W. It is this curious feature, chiefly, which induces me to hesitate regarding the identity of the anticlinal N. of the tunnel, connected with these S. dips, with the anticlinal arching the Peach Mountain Vein on the West-West Branch ; for such a swing Northward of the N. outcrop of this folded basin of the tunnel seems strongly to imply that the axis on its N. is sinking and expiring Westward.

This Peach Mountain short axis, or that N. of the Minersville Tunnel, takes in its course Westward a position in the S. slope, or high in the ridge, which also embraces the basin of the Phœnix South Coal ; while the axis O of the hollow next S. of the West-West Branch south outcrop of Peach Mountain Coal, in ranging Westward, passes through the valley of the Southern part of Klauser's and Faust's farms, at the N. foot of the high wooded ridge which lies next N. of the turnpike road.

All the hill of the Kantner Coal has N. dips Northward to the white house in the woods (L. Garner's) ; the same N. dips are opened on the Wagner Tract.

Spencer's line, Eastward of Wolf Creek, extends 900 yards to the Delaware property. A new slope at Wolf Creek will command a fine field of gently South-dipping coal by the flattening of axis O, even to the N. dip of the Kantner Coal.

This anticlinal extends from a point W. of the West Norwegian nearly, if not entirely, to the Swatara. It constitutes the South-bounding flexure of the basin of the Peach Mountain Coal throughout this distance. Passing just S. of the town of Minersville, I have given it a designation derived from this well-defined position. On the West-West Branch the place of

the axis, or centre of the arch, is in the ridge next S. of the South Phœnix Slope, and S. of the Peach Mountain Basin of the N. side of the same ridge.

At Weaver's, on Muddy Creek, an anticlinal, which I am disposed to regard as the same, passes between the dwelling-house and the Breaker of the Peach Mountain Coal. It is seen again at the bend in the road turning up the main Muddy Branch, and finally on the East Branch of Swatara, where the Spohn Vein, so called, of Muddy Branch, displays an anticlinal just at the water-level exposing its outcrop near the roadside. Beyond this point it has not been as yet detected.

Declining thus progressively from Minersville westward, this axis on the West-West Branch lifts out only the Peach Mountain bed; but this coal arches it at a height of nearly 100 feet above the valley, having been there mined over the anticlinal from the N. into the S. dip.

At the ravine at Weaver's the anticlinal exposes above the water-level a coal evidently one or two stages higher than the Peach Mountain Vein, which, immediately N. of this, is mined downward in a slope for 70 yards on a S. dip of 45°, proving certainly that coal to underlie this small surface-vein of the saddle.

It is probable, I have said, that the expiring anticlinal in the so-termed Spohn Vein, on the East Branch of Swatara, is a prolongation of this axis. This view will not be contravened by the interesting fact, that the Spohn Vein, so called, of M^c^Donald's Branch Dale Colliery, worked Westward from the S. dip of another more S. axis, has been mined forward to this anticlinal point on the Small Swatara, even if it should hereafter appear, as I think it will, that the axis of the Branch Dale Slope expires W. of Muddy Branch before reaching the Swatara waters. As thus the South-dipping workings of the more Southern basin may be permitted to take their place on the S. flank of the main axis before us, if this axis really does extend itself even one mile Westward, it may contribute in a small degree to flatten the S. dips of the wide South-dipping belt of strata in its line of prolongation; that is, in the wide plateau which lies between the foot of the Thick Mountain and the Big Lick Mountain.

AXIS OF WEST-WEST BRANCH, OR ANTICLINAL P.

A fourth subordinate anticlinal crosses the valley of West-West Branch at a ravine which has been scooped out on the very back of the axis, about 850 feet S. of the final or S. dip of the Peach Mountain Coal. It would seem not to range far Eastward, certainly not to the valley of West Branch, nor has it been detected even as far as the Minersville and Llewellyn Road. Westward from West-West Branch it passes along the valley at the N. foot of the high wooded ridge lying N. of the Tremont Road, taking its course towards Muddy Branch through a range of open fields. On the E. side of the West-West Branch this anticlinal exhibits steep, almost perpendicular, N. dips, while its S. dips are about 35°.

It is not easy to decide at present precisely what coal it lifts nearest to the water-level on the West-West Branch, but it is very manifest that it does not bring up the Peach Mountain Vein. If this axis prolongs itself as far as the Muddy Branch, its course must take it just about to the neighbourhood of the sawmill pond S. of Weaver's, where the evidence of an anticlinal flexure is suspected.

GRISCOM'S AXIS, OR ANTICLINAL P.

About 1000 feet S. of the parallel of the short axis P, just described, there ranges another, distinctly traceable between West Branch and West-West Branch. From the absence of the axis P on the West Branch, there exists quite a wide belt of South-dipping measures between Minersville and the N. dips of the axis P. This latter is marked externally, on the E. side of West Branch, by a ravine or hollow in the hills, and on the W. side by a quite prominent knob. Thence it ranges Westward, crossing the Minersville and Llewellyn Road, and through the Griscom estate, where the very axis itself has been shafted on. Thence it runs forward to the West-West Branch, where, in the first railroad section above the town of Llewellyn, its nearly exhausted force is shown in a flattish undulation of the coal-shales with a N. dip of only 10° and a S. dip of 20°. This axis is evidently in greatest strength between the West Branch and Griscom's experimental slope upon it ; for throughout this part of its range the N. dips approach in most places to perpendicular ones.

It is possible that this anticlinal prolongs itself Westward of the West-West Branch, in which case it must pass through nearly the crest of the high ridge N. of the Tremont Road, and, if it appears on Muddy Branch, must meet this very near the old Spohn Mine. Almost in a line with this anticlinal we have the proofs of a flexure—possibly this one—more than 1 mile to the W. of its exhibition on West-West Branch, at Weaver's old Spohn Vein workings, on the W. side of Muddy Branch. Here an anticlinal—which, however, seems to droop Eastward, or rise toward the W.—just lifts the Muddy Branch Spohn Vein to a small height above the water-level, permitting both dips, which are but 50 feet apart, to be entered by one drift nearly under the arch. This axis, after rising to McDonald's Branch Dale Colliery, where it lifts and separates the same Spohn Vein into two somewhat remote outcrops, soon again subsides, and apparently disappears altogether, permitting the S. dip of the Spohn Vein, as once already stated, to swing its outcrop Northward, with a gentle dip and a greatly elongated breast, until it takes its station as the South-dipping vein of the next anticlinal north, or in the line of the general axis.

As there is at present no systematic mining along this anticlinal belt, or N. of it, connecting it with well-ascertained ground N. of Minersville, it is impossible to decide what particular coals they are which saddle the axis on the upland through the Griscom estate, or what beds it lifts above the water-level in the valley of West Branch. Most probably, however, the coals which it imperfectly develops are the small seams above the Peach Mountain Vein and below the Spohn. How far E. of the West Branch this anticlinal may extend, the obscurely-developed condition of the district does not permit us now to determine. Nevertheless, it is so nearly in a line with the course of the anticlinal I, visible on the W. side of the West Norwegian, N. of the old Spohn workings, or next S. of the Peach Mountain Basin, that I strongly incline to regard it as either the prolongation of this undulation, or as one of a chain of axes including both.

LLEWELLYN NORTH AXIS, OR ANTICLINAL Q Q.

Another anticlinal, the sixth Southward of our present group, more faintly indicated than the last, from which it lies Southward about 1200 feet, crosses the West-West Branch just N. of the village of Llewellyn, and, ranging thence to the West Branch, is seen on this valley in the

flat arch a little N. of the 7-mile post of the West Branch Railroad. It is evidently a feeble undulation, for its N. and S. dips are both at low angles as well on the West Branch as on the West-West Branch. This axis occurs in the range of the small Sandrock Coals of the Norwegian district, but what particular beds it lifts to the water-level at the only two valleys which intersect it, we have not the means of knowing.

BRANCH-DALE LEWIS VEIN AXIS, OR ANTICLINAL P WEST.

South of the Spohn axis of the Branchdale Colliery, about 700 feet, occurs the outcrop of the Muddy Branch (Weaver's) Lewis Vein. Low on the S. slope of the ridge, and just in this outcrop, the strata turn from a gentle S. to a N. dip, implying the presence here of another anticlinal. This seems to have no existence on the Muddy Branch, or Eastward of it, but from the point now spoken of Westward to the W. side of the main Swatara, it would appear to range as a continuous anticlinal. This axis seems to rise towards the W., for on the E. side of the E. tributary of the Swatara, a coal-seam, pretty evidently the same Lewis bed, is exposed above the water-level in separate North and South-dipping branches, which there outcrop 335 feet asunder, each of them perforated by a mine-drift. Moreover, the vein separates Westward of Branch Dale into two outcrops despite of the rising of the ground. On the W. side of the Swatara the position of this anticlinal is about 300 feet S. of the second railroad section N. of the Tremont Road, or just over the hill from Tobias's, but what coal it there lifts to the water-level, the poverty of exposures prevents our ascertaining.

This subordinate axis—the next anticlinal N. of that of the Big Lick Mountain—here exhibits N. dips as steep as 80° or 85°; and as these fill a belt of considerable width, we may infer that the flexure still retains some magnitude, and may range Westward even a mile or two before it altogether expires. In confirmation of this view, we may observe, in the broad flat elevated table-land which fills up the space between the South-dipping flank of Thick Mountain and the summit of Big Lick Mountain, the traces of a ridge holding its position all the way to the valley at Donaldson. Indeed, we can scarcely account for the wide expanse of high level ground in this space, but by assuming a lifting of the strata into a flat wide arch, or at least a flattening of the S. dips all along the plateau.

At the Branch Dale Colliery (McDonald's) the distance between the Lewis Coal saddle and the top of the Spohn Vein slope, in a N. and S. course, is 650 feet, and nearly in the middle of this space ranges the crest of the low synclinal ridge into which the Spohn Vein has its S. dip.

The thickness of this so-called Lewis Vein here is in all 9 feet, divided into three benches.

On the E. tributary of the Swatara the North-dipping part of this seam has a thickness of 6 feet.

LLEWELLYN MIDDLE AXIS, OR ANTICLINAL Q.

Between 700 and 800 feet S. of the Llewellyn axis F there occurs another still fainter and more obscure anticlinal, visible both at the town of Llewellyn and in the West Branch Valley. It is most conspicuous where it is intersected by the latter near the great bend of the West Branch stream, a few hundred feet S. of the railroad 7-mile post. Here it lifts above the water-level the same sandstones and other Coal-measures which are elevated by the anticlinal N. of it, and

it exhibits, like it, very gentle dips both N. and S. of the axis. At Llewellyn, in the cut on the railroad near the N. edge of the village, this undulation, if indeed this be the same, is feebly expressed in a short flexure of the sandy olive-shales. (See this part of the West-West Branch Section.) Whether it ranges Eastward of the West Branch we cannot say, but we know that on the West Norwegian, in the belt of the upper Sandrock Coals, where this axis ought to range, if prolonged so far, there are no symptoms of its existence.

I have now exhausted the description of the group of subordinate anticlinals lying N. of the parallel of the Big Lick anticlinal, and S. of the Primrose Hill and Middle Creek anticlinal M, or that of Swatara Falls—so far, at least, as respects the complicated district enclosed between the valley of West Branch and that of the Swatara. I proceed next to an examination of the contents of the troughs or basins included among these axes.

AXIS OF BIG LICK MOUNTAIN, OR ANTICLINAL Q.

A regular and comparatively long anticlinal axis, its central portion well marked in the topography of the country, ranges nearly with the crest of the Big Lick Mountain of Donaldson, and its prolongations E. and W. It divides a regular basin at the S. base of the Thick Mountain from another equally well defined trough, which it encloses between itself and the Little Lick axis R. This Big Lick anticlinal has not as yet been definitely traced E. of the Swatara by any mining operations, or by external indications, nor do I think that it extends very far beyond it, for at that stream it is greatly reduced in force, and shows signs of soon subsiding. It crosses the Swatara Valley at a point a few hundred feet N. of the Pottsville and Tremont road, where the very arch of the anticlinal may be clearly seen in a cutting on the Swatara Railroad, about due E. of Tobias's Tavern. From this point it ranges W. in a very straight course through the ridge next N. of Tobias's, to which it imparts a more and more definite form and greater regularity of crest as it advances. It then crosses Middle Creek and Watering Run, where the North and South-dipping strata of the flexure are well exposed in several places in the cuttings of the Middle Creek Branch of the Mine Hill Railroad. Thence it ranges in the same line to where it crosses Good Spring Creek near Donaldson, beyond which, still ascending and dilating, it finally merges itself, between 2 and 3 miles W. of the notch of Good Spring Creek, into the N. flank of the Little Lick Mountain. The ridge which contains it, here becomes a mere shoulder or expansion N. of the Little Lick Mountain by the rising W. of the basin between them. The axis, however, maintains its place for several miles further along the N. side or brow of the South-bounding ridge of the Wiconisco Basin; an arching of the strata being still conspicuous in a deep ravine on the N. side of this mountain, nearly opposite Klinger's Gap, where a swell in the ridge denotes its presence. In all this distance, from the ravine of Watering Run next W. of the Main Swatara Creek, to the Good Spring Valley, if not further, the anticlinal has the form of a regular single arch, abruptly curved at its summit, with dips averaging 45° on its S. flank, and perpendicular ones on its N. At the Swatara, where the axis seems to be preparing to die away E., the N. dips are losing their high inclination, being scarcely more than 70°; and what is more significant of the exhaustion of the undulation in this direction, the belt of North-dipping strata is here very narrow, not more than some 70 feet wide between the actual saddle and the South-dipping measures of the basin N. of it. (See Swatara Section.) It is doubtful whether this flexure extends at all East of the E. tributary of the Swatara.

From what I have indicated of the elevation of this axis Westward, and its progressive declension to the Swatara, and the rising out of the basin between it and the Little Lick anticlinal, it must be apparent that, throughout several miles of its range E. from Klinger's Gap, it is saddled only by the coals of the White-Ash series. No mining developments thus far made give us the means of ascertaining where the Grey-Ash coals first take their place on the back of the anticlinal; but their W. limit over the axis is probably 2 or 3 miles W. of Donaldson. From all that can be ascertained of the coals of this anticlinal near Donaldson, it seems probable that the upper Grey-Ash seams lie under the water-level at the gap of Good Spring Creek, at the line of the axis, as much perhaps as 150 or 200 feet. The several coals which flank it in the Big Lick Mountain from this locality E., therefore, all appertain to the great Red-Ash series; and as these are five in number at the gap near Donaldson, and higher ones overlap the axis successively as it advances E., it is plain that the strata which it exposes on the Swatara belong to a very high position in the Coal-measures. From this fact we derive the further inference that the basins to the N. and S. of this anticlinal, and especially the latter, contain an extensive set of Red-Ash coals of the middle and upper groups of the series.

AXIS OF LITTLE LICK MOUNTAIN, OR ANTICLINAL R.

This prominent and interesting anticlinal, which, W. of Tremont, elevates the broad summit of the Little Lick Mountain, is, though of limited extension E., the great flexure of the W. end of the coal-field; for, by lifting to the surface the older formations beneath the Coal-measures, it separates the main basin of Pottsville into its two branches, the Dauphin and the Wiconisco basins. I have elsewhere identified it as the prolongation of the great anticlinal of the Half-Fall Mountain of the Juniata, and of the Path Valley of Franklin County. In the Little Lick Mountain, which is the high swelling portion of this anticlinal, rising and widening from Tremont W. to the oval margin of the deep red-shale valley, or "Kettle," as it is called, this anticlinal is a complex one, embracing, in reality, three parallel axes. The first and chief of these appears immediately at the N. edge of the village of Tremont, on the N. of the pointed spur descending there to the water-level, and is cut in Spangler's Tunnel. It ascends first along the crest of the main E. spur of the mountain, and thence pursuing its course obliquely W. in the same straight line along the S. brow of the mountain, runs through the middle of the high flats onward to the most concave part of the great "Kettle."

A very few hundred feet to the N. of this principal axis arises another, not traced as yet E. of Tremont, but showing itself first about half a mile W. of Tremont, on the N. slope of the mountain, where its structure has been developed in the mining operations of Spangler and Eckel.

A third and seemingly insignificant flexure occurs further W. up the mountain. Its position is between the two above described.

The main flexure of Tremont shows a dip of about 45° on its S. side, and a perpendicular one on its N. side. This steepness of the N. dip extends to beyond the point where the other prominent axis becomes fully overlapped, W. of which, along the now elevated ridge, the basin between the two axes exhibits N. dips of a less degree of steepness.

In like manner the second axis (that of Eckel's Mines) is a sharp flexure, with a perpendicular dip on its N. side for a considerable distance W. from its point of origin on the slope of the mountain.

Each of these waves gradually dilates and flattens in advancing W. They ascend in that direction at about the same rate; and the synclinal trough between them, marked nearly by the crest of the mountain as far as the passage of Rausch Creek, grows gradually shallower, and becomes at the same time wider by a slight divergence of the two axes.

How far the main axis prolongs itself E. from Tremont through the coal-field, it is impossible, in the present imperfectly-developed state of the belt which should contain it, definitely to determine. On the Swatara, about 1000 feet N. of the main anticlinal of the Red or Gate Ridge, we find indications, in the new cuttings of the Middle Creek Branch of the Mine Hill Railroad, of an anticlinal flexure; at least I so regard the steep-dipping rocks of the second cut of the railroad, for I am inclined to view them as overturned, and as implying, therefore, the existence of an axis with inversion not far S. of them. If there really exists an axis here, the question is, What is the probability of its being that of the Little Lick Mountain, prolonged thus far to the E.? It would seem to be nearly in the line of that flexure, though perhaps a little too far N. Let it be observed, that between Tremont and the Swatara we do not find any exposures of either N. or S. dips in the line where the axis should pass. As regards the probability of the identity of this axis of Swatara Creek with the Tremont flexure, I must suggest that some considerations are adverse to it. First, the space is a long one—as much as 3 miles; and as the Little Lick anticlinal is evidently declining rapidly at Tremont, we may fairly infer that it ceases altogether before reaching the Swatara. Again, N. of the West-running reach of Middle Creek in the ridge which the South-running course of the stream intersects, only S. dips are to be observed; and if the Little Lick axis were of much magnitude opposite to this hill, we might almost certainly look for N. dips at its S. base.

Of the coals exposed along this anticlinal axis, I would observe, that at Rausch Creek we find the main flexure presenting a beautiful wide arch or saddle, with gentle dips of the upper Egg-conglomerate and overlying strata, the conglomerate rising even on the E. side of the stream some 60 or 80 feet above the water-level. Across this arch of coarse conglomerate, the three lower White-Ash coals, which in this quarter underlie the so-called Big Vein, roll gently over in succession as we ascend from the valley E. along the axis to the level of the high flats; and a little higher up we discern the bench or terrace which denotes the crescent-like line of outcrop of the Big Vein itself, still considerably W. of the flats. It is obvious that, W. of Rausch Creek, this anticlinal, rising and spreading, becomes more and more denuded of the lower White-Ash coals which here still arch it, until at last, in the district beyond Kimmel's Tavern, at the fork of the turnpike, only the lower conglomerates, with the very lowest coal-beds, cover, in an almost horizontal position, the broad swelling summit.

Descending from the high flats E. along the axes of the Little Lick Mountain, the lower Red-Ash coal-seams saddle in succession in ascending order the double anticlinal of the mountain. Pursuing the subsiding crest towards Tremont, the middle Red-Ash coals come in, one after another, and when we reach the point of the spur at the water-level at Tremont, we are evidently on coals which are high in the Red-Ash series.

A more detailed account of those exposed by mining and shafting in the Little Lick Mountain will be presented in another place.

AXIS OF RED MOUNTAIN, OR GATE RIDGE ON ANTICLINAL S.

The W. portion of the great anticlinal now before us, or that included between the West-West Branch and its W. termination, opposite the Fishing Creek Gap in Sharp Mountain, is connected with a great feature in the topography of the coal-field. This well-marked and straight crest of the ridge called Red Mountain, subsides as a fold in the South-dipping strata of the N. barrier of the Dauphin Basin. The axis of the flexure crosses Lorberry Creek at the arch of the Big Coal, sometimes called the Rock Vein, where it lifts this large White-Ash seam to a position a little above an elevated water-level. It pursues thence the summit of the ridge, and appears on Rausch Creek as the first main ridge N. of the Sharp Mountain, the axis coinciding very nearly with the knob on the W. side of that valley. Here it is cut to a deeper level than at the valley of Lorberry Creek, and yet it does not bring to the water-level quite as high a part of the Coal-measures ; for the same Big White-Ash Coal, which is above the bed of that valley, lies under the bed of this at the arch or axis, a depth probably of from 50 to 100 feet. Between Rausch Creek and the Swatara at Tremont, the axis of the anticlinal occupies rather the S. brow of the rounded summit of the Red Mountain. The whole arch is beautifully exposed in the notch of the Swatara, where no less than ten coal-beds, all of them of the Red-Ash series, flank the axis between the N. and S. limits of the gap. (See Section of Red Mountain, Plate III.) The flexure at this exposure, and at Rausch Creek, is more compressed, or displays much steeper dips, both N. and S. ones, than on Lorberry Creek. Indeed, for the entire distance between Muddy Branch and Rausch Creek, the N. side of the arch is almost perpendicular, while the average plunge of the beds on the S. side is about 45°. At Lorberry Creek, Rausch Creek, and the Swatara at Tremont, it is a regular and single anticlinal flexure of the normal form ; but between the gap of the last-named stream and that of the East Branch of the Swatara, it loses this simplicity by the introduction of one or more subordinate undulations which attend the main axis, thence the whole way Eastward to the vicinity of the West Norwegian.

This change in its structure the reader will readily discern, by inspecting those portions of the Western series of sections which depict the Red Mountain rocks, and comparing those W. of the East Branch of Swatara with those E. of it.

At the natural section where this stream passes through the anticlinal ridge, the Swatara Railroad exposes in its cuttings the exact features of the central parts of the anticlinal, enabling us to note two closely-connected flexures, distant from each other only about 350 feet.

The more Northern of these is a compressed or folded axis inverting the strata just N. of it a little past the perpendicular, and lifting those immediately S. of the bend to a steepness almost as great. Though it appears to be a subordinate contortion in a synclinal trough of sandstones and shales lying between the more regular axis S. of it, and the succession of S. dips N. of it, I am disposed to regard it as the compressed termination of the anticlinal of the Little Lick Mountain, or axis R. Occurring in the midst of synclinal dips, it repeats at the level of the railroad a bed of coal, and the shales embracing it, four times within their narrow basin. (See Section on Swatara Railroad, near Middle Creek Railroad Junction, Plate III.)

The Southern flexure adjoining this contortion is just at the axis a flattish arch elevating somewhat lower strata than those involved in the contortion above referred to. This is perhaps the true axis S, or that of the Red Mountain. But a question here arises, whether the present, or any other of our longer anticlinals, possesses that undisturbed symmetry and regularity which are

implied in the notion of the continuous prolongation of one simple axis-line? Certain it is that different anticlinal belts differ in a marked manner in the degree of complexity or simplicity presented by them near the summit of the wave, and this of the Red Mountain, or Gate Ridge, is an instance of this difference even in the several portions of its own long line. It is simple from its W. origin Eastward to beyond Tremont; complex from that meridian onward nearly to Pottsville; simple again, with slight inversion, from the Norwegian to Belmont; and again contorted or undulated from that quarter forward to where it smooths itself into a flatter and more symmetrical wave between the parallels of the Five-mile Board and Middleport, preparatory to merging itself into the Sharp Mountain.

N. of the irregular flexure in the centre of the Red Mountain anticlinal at the gap of the East Branch of Swatara, there occur a series of steeply South-dipping strata, distant from the axis rather more than 1000 feet. They bear indications of being overturned, and the idea of their inversion is strengthened by their having the unusual dip of 70° S., and lying N. of other beds dipping with the normal amount of pitch of 40° to the same quarter. If these rocks, which are exposed in a vacant cutting of the Middle Creek Railroad, are really overturned, there is undoubtedly one important anticlinal ranging at the N. base of the Red Mountain, at a distance of some 700 or 800 feet N. of its proper central axis. This implied anticlinal R is the one to which I have before alluded as being nearly in the line of prolongation of the main Little Lick axis, but a reconsideration of the evidence induces me to regard it as lying too far N. If that axis extends thus far towards the E.—and there are reasons for supposing it does not—its more probable prolongation is the steep flexure R.

The next point E. at which the Red Mountain axis is distinctly exposed, is on the lower Muddy Branch at Bettinger's Southern Mines on the Dundas Lands. Here the flexure is apparently single, but it shows its usual degree of compression, for the dips on the N. side of the axis are perpendicular, and those on the S. side amount to 40° S.

It is worthy of note, that at the pass of the Muddy Branch, N. of this point by several hundred feet, we recognise another anticlinal, agreeing in its relative position to the axis of the ridge very nearly with the place of the assumed axis R, on East Branch of Swatara, N. of the prolongation of the Little Lick anticlinal. This is near the sawmill on the Muddy Branch at Bettinger's North Mine. That there is an important axis here, along the N. side or slope of the Red Mountain or Gate Ridge, is obvious from the dips visible on the railroad, a regular S. pitch of 30° up to 45° meeting abruptly high angles of 80° and more, with all the appearance of inversion in the strata. We may moreover observe, S. of this indicated synclinal or basin, a long narrow longitudinal valley corresponding in range with the Little Lick line of anticlinals; and this is, in all probability, the position of a sharp bold axis overturning the strata on its N. side into this high dip of 80° S.

On the West-West Branch below Llewellyn, we again meet with the main anticlinal of the Gate Ridge or Red Mountain. It is indicated near the Salem Colliery in the passage from true S. dips into the overturned ones of the so-called Gate and South Gate Veins of this locality.

South of the main axis there is a more trivial undulation affecting the outcropping portion of the so-called Salem Vein, but whether this is an axis of any length, or only a mere local roll, the mining explorations of the district do not show. My impression is that it has but a limited extent. (See West-West Branch Section near Silverton.)

About 1300 or 1400 feet N. of the inverting or folded flexure of the Gate Veins there are indications, in a series of Sharp S. dips lying next S. of the more gentle ones at the town of Llewellyn, of the presence of another axis, also with inversion; but it must be admitted that the evidence of this fold is obscure. It will be noticed that the place assigned to it relates it to that which we have seen existing N. of the chief one both on Muddy Branch and on Swatara.

CHAPTER IX.

COLLIERIES BETWEEN THE WEST NORWEGIAN AND THE SWATARA.

Having in the preceding chapter traced, with all the precision at present practicable, the course of the numerous anticlinal flexures, great and small, which range from the West Norwegian Valley to that of the Swatara, and pointed out the principal coal-seams which saddle them, I shall, in order to complete our view of this part of the coal-field, offer here a series of notes upon some of the more instructive collieries. These notes were taken in 1853, and therefore are not in all their particulars applicable to the present day; yet as many of the data given in them are of a permanent nature, and of importance as a key to the position of large stores of coal under the water-levels of the country, they are retained without alteration. If the time yet to elapse before the issuing of the work permits, the existing condition of these and many other collieries will be noted in an Appendix. As in the preceding chapters, the localities will be treated in regular order from N. to S., and along each belt from E. to W.

MINE HILL GAP COLLIERY (JOHN DOHERTY'S).

Coals—1*st Bed.*—The Mammoth seam, on the W. side, is from 12 to 13 feet thick, with 9 feet of coal: it has three genuine benches; the lower has from $3\frac{1}{2}$ to 4 feet of clear strong coal and 3 inches of slate; the middle bench has 18 inches of regular coal, and from 3 to 4 feet of Bone coal and slate-parting; and the upper bench is $2\frac{1}{2}$ feet thick. The dip is about 30°. The roof is sandstone, becoming slate towards the E. It is separated from the next overlying coal, 140 yards from the gap, by only 4 feet of slate: this interval augments on going W. On the E. side of the creek, the two are parted by a thin seam of slate.

The 2d Coal is the Black Heath bed, 4 feet thick, with 3 feet of coal: above this are 10 feet of slate, with two thin coal-seams, one 12 inches, the other 6 inches thick.

The 3d Vein.—The Black Valley Coal is 10 feet thick, and has 9 feet of good coal. It has been mined above water-level from the W. side of the stream almost to Wolf Creek.

DUNDAS COLLIERY, No. I. (ABOUT 400 YARDS WEST OF DOHERTY'S).

The *Slope* on the Black Valley Coal dips 35° S. The average thickness of the bed is 9 feet, with two benches and no parting-slate. It has a hard slate on the top of the coal, and sometimes a quite thick one; at other places there is none. About 28 yards N. of the slope is what may be the Black Heath Coal, or it and the Big Coal together: the thickness is 14 feet.

A tunnel enters the hill S. of the Slope Coal, and cuts the Silver Coal 21 yards in, and at the end of the tunnel occurs the Black Valley (Slope Coal). This tunnel is 110 yards long. The gangways extend E. three-quarters of a mile, and W. to the gap about 700 yards.

MINERSVILLE.—BASIN *O o.*

Wagner's Tunnel cuts a basin with two coals on each dip. Spencer is now (1852) sinking a slope Southward on Coal No. 2 of the tunnel. The basin of Coals No. 3 and 4 in this tunnel is apparently the basin next N. of the mouth of the Minersville Tunnel.

Nos. 3 and 4 Coals basin out and rise to the E. within 700 yards.

Minersville (Lewis's) Tunnel.—Cuts four coals forming a folded synclinal, the axis dipping Southward : there is an anticlinal just at the tunnel's mouth. The first coal cut is 8 feet thick : the last measures from 8 to 9 feet—is supposed to be the Peach Mountain Coal. The middle coals, 4 and 3½ feet, basin together. The tunnel is 80 yards long. The main gangway was driven on the Back Coal. It was driven 280 yards E. (?) and then the strata became confused.

WEST BRANCH.

The anticlinal F, West of Mount Laffee (West Norwegian), which at West Branch arches the Oak Hill Coal and its overlying coarse conglomerate, is traceable with the similar flexure of the Oak Hill Colliery on Wolf Creek, where the same overlying conglomerate arches beautifully over the coal, just above the water-level, on the E. side of the valley. Here it has gentle S. dips and steep N. ones. It is traceable thence Westward through the hollow of the Western Branch of Wolf Creek, and into the high table-land which connects the Primrose Hill with the flank of Mine Hill ; and finally, in the vicinity of Woodside, it loses itself high on the slope of Mine Hill, where its vestiges are perceived in certain irregularities and flattenings in the S. dips of the Black Valley Coal, and the other lower beds of that range.

There are two coals close under the coarse Nut and Pea-conglomerate which saddles this Northern axis. These are, in all probability, the two Norwegian Orchard Coals. The higher is within a few yards of the overlying conglomerate, and the lower is in some places 5 feet beneath the upper. This lower coal is in some places 10 feet thick, the upper 5 feet. By a careful examination of the measures on Oak Hill and at Mount Laffee, the Oak Hill coals were decided to be the Orchard beds of West Norwegian. Between the conglomerate covering the Oak Hill or Orchard coals of West Branch, and the conglomerate rock of the Big Diamond Coal, are three small coals on West Branch. The highest of these is the Bast Big Diamond Coal of Wolf Creek : the other two inferior ones are not named here, but are seen also on West Norwegian.

Coals on the S. Side of Mine Hill Gap—Basin C E West :—

a. There are two bony coals over the great conglomerate, separated by a rib of rather coarse Nut-conglomerate. Each coal is about 4 feet thick.

(It has been supposed that the Jugular Coal underlies the Big conglomerate, and is under the arch of Mine Hill.)

b. The Skidmore Coal is separated from the upper bony coal by coarse-grained dark-grey sandstone, and Pea-conglomerate. It has not been opened here.

c. A small coal lies about 20 yards above the Skidmore Coal ; the interval is composed of slate and shale. The coal is about 3 feet thick.

d. We then have the Mine Hill Coals, or Mount Laffee Mammoth seam, consisting, at Mount Laffee, of two beds, the lower 21 feet, and the upper 12 feet thick, separated by about 30 feet, but this space is very variable. At Western Mount Laffee Colliery the separating mass of slate is only 2 feet thick. The top coal is here about 13 feet thick, the under one about 20 feet. The upper bench is supposed to be the Black Heath bed.

The Diamond Coal of West Branch is identified with the Diamond Coal of Wolf Creek, by an overlying coarse Nut-conglomerate. The *Cockle* Coal has a Pea-conglomerate above it. Most probably this Cockle bed is the S. Diamond of Silver and Mill creeks. The Lower Orchard of West Branch has a remarkably black fissile slate over it. The basin of the Oak Hill coal dies out Eastward, and the dips become S.

Fogerty's Colliery, W. of Westwood.—The slope is down on the *Black Mine* Coal about 235 yards: the dip at the top is 38° S.; at the bottom it is much steeper: the average thickness of the coal is 7 feet in three benches, with little or no partings. The coal is good; there are three lifts, and gangways on each lift, which run E. and W., and are nearly straight; the middle gangway is worked W. about 830 yards. The roof and floor of the bed are regular. From the bottom of the first lift a tunnel is driving Southward to the Tunnel Coal. At the bottom of the second lift, another tunnel is already driven from 55 to 60 yards, also to the Tunnel Coal. From the tip of the slope, the bearing to Pott's Slope, on the Black Mine Coal, is N. 70° E.

SECTION OF THE COAL-MEASURES IN SHARP MOUNTAIN AT THE WEST BRANCH GAP.

The strata being somewhat inverted or dipping S. 80°, the actually ascending order is apparently a descending one, but we shall commence as usual with the originally lowest beds.

1st Coal—Twin Vein.—The lowest coal discovered in the Sharp Mountain at this gap is the Double or Twin Seam; also at the base of the series at Mount Carbon and elsewhere. It consists of—coal 2 feet, slate 9 feet, and coal 3 feet.

Between the Twin Coal and the next overlying bed, there intervenes a body of conglomerate and sandstone about 150 feet thick.

2d Coal—Plumbago Bed.—The second seam or Plumbago bed at Pottsville, measures at the West Branch from 8 to 10 feet, though, being overturned and crushed, it is highly probable that such are not its true dimensions.

Overlying the Plumbago seam is a mass of sandstone, about 140 feet thick.

3d Coal, or Barcleugh Vein.—This seam here measures about 6 feet, but its true size is probably greater. Between it and the next coal the strata are sandstone and slate, filling a space of about 90 feet.

4th Coal, or Knickerbocker Vein.—This coal, as proved in a drift at the West Branch, showed a thickness of 6 feet.

Overlying the Knickerbocker bed we again meet with sandstone and slate, filling an interval of about 60 feet to the next coal-seam.

5th Coal, or Three-Feet Vein.—This bed measured at the point at which it was opened by a drift, about 3 feet, as its name implies.

From the thin bed just mentioned to the next or Furnace Vein, the perpendicular distance through the strata is about 300 feet, the measures consisting of sandstone and slate.

6th Coal—Furnace Vein.—This bed displayed a thickness at the spot where it has been mined, of from 4 to 6 feet, the coal being, in the main, good and sound.

Above the furnace-bed occur sandstone and slate through a thickness of 120 feet to the next coal-seam.

7th Coal.—This is a small bed, apparently only 2 feet thick. It is the uppermost of the series of coals clearly opened in the Sharp Mountain at this locality.

The above measurements are on the authority of Mr Bennett. Our own earlier measurements, made when the strata were less distinctly developed, are somewhat different.

COLLIERIES—WOLF CREEK.

Slope on the Bast White-Ash Coal (the Primrose).—This slope was sunk 120 yards in 1853; the dip was not regular, being flatter at the top than at the bottom. The thickness of the coal is irregular, being from 6 to 12 feet in thickness in two benches. The gangways run E. and W. into faults in both directions. There is very little top slate: the Slope Coal had not been worked for three years. From the bottom of the slope the strata were tunneled N. nearly 100 yards. At 50 yards the tunnel cut the Black Valley Coal, and at its end it cut the Black Heath Coal. The Black Valley Coal has from 7 to 8 feet of coal and dirt: it was worked E. to the line, and Westward it ran into a fault.

The Black Heath Coal has 4 feet coal, with irregular dip: it has three benches, with no partings: the gangways run E. and W. several hundred yards. In tunneling 40 yards further N. they cut the Seven-feet Coal, which was not good here; but at Serril's Mine further W. it was good on the top lift.

Bast and Pearson's Slope on the Bast White-Ash Coal.—This slope was down 169 yards. The coal is 8 feet thick in two benches, with no partings; the top and bottom are regular: it has three gangways; one, at a depth of 85 yards, runs W. 700 yards. The slope does not start on the Bast White-Ash coal. It runs 85 yards down in a small 3-feet bed S. of the White-Ash coal; from thence a tunnel was driven 20 yards N. to the White-Ash bed, and there a counter-gangway was started. The slope then continues through slates, and cuts the White-Ash coal as in the diagram. At the bottom of the slope the gangways run E. 92 yards, and W. 170 yards, at the end of which there is a tunnel driven N. 90 yards.

FIG. 174.—Bast and Pearson's Slope.

Serril's Lower Tunnel.—This runs Northward 265 feet to a coal (the Black Valley). A gangway extended W. on this nearly 500 yards, where the tunnel was driven Northward 62 feet to the Black Heath coal, and still further to the Skidmore (?) coal.

Serril's Upper Tunnel.—The accessible thick White-Ash coal-beds at the foot of Mine Hill are entered by Serril's Upper Tunnel. They are the Back or Skidmore, the Black Heath, and the Black Valley beds, and have the dimensions and distances apart shown in the accompanying cut.

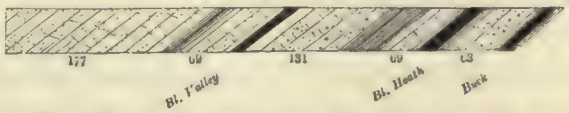


FIG. 175.—Serril's Upper Tunnel, Wolf Creek, looking E. 1 *inch* = 200 *feet.*

Holman and Company's Slope.—The slope on the *Oak Hill* Coal is down 80 yards to a basin, then 30 yards on the N. dip to a saddle. The

coal averages from 8 to 10 feet in thickness, frequently even 14 feet. The N. dip is thickest; it is in two benches; the top is 7 feet thick, with bony coal between. On the top of the coal lie 14 inches of slate, then sandstone, &c. From the bottom of the slope the gangway runs E. and W. Eastward, the gangway turns its course to the N. base of the saddle of conglomerate at the Breaker. The distance of the turn Eastward from the slope is 150 feet. It is all worked off by water-level drifts.

Bast and Pearson's Slope on Red-Ash Coal.—The coal-bed of this mine is the so-called Big Diamond, 5½ feet thick in two benches. The top rock is of slate and bony coal; the bottom is of slate and hard rock; the dip is from 42° to 45°, and regular; the slope is 150 yards down; the gangways run 1400 yards E. and 1700 W. They are now (1852) tunneling N. to the two small beds: behind them they expect to cut the 3-feet coal at 90 yards, and the next 10 yards further W. The gangway ran into a fault towards its end: it has been driven 200 yards on the fault.

Kear's Slope on the Oak Hill Grey-Ash Coal (Lower Orchard Bed).—This slope is down 200 yards.

Jeanes and Spencer's Slope on the Peach Mountain Coal.—This mine is down 120 yards, with S. dip: in one lift the dip is 35°. The coal is 8 feet thick in four benches; in the first bench it is 3 feet thick, and in the second and third 9 inches, and in the top bench it is 4 feet thick, with a little slate between them.

From the bottom of the slope a tunnel was driven 220 feet N. to the Platt coal, 3½ feet thick: the gangways run E. and W.; the W. gangway runs into a dirt-fault at 600 yards. The distance between the Platt and Spencer coals at water-level is 325 feet. From Spencer's Slope to a small coal S. is 816 feet. The distance across the strike, between the Spencer and Little Diamond coals, is 550 feet.

From the outcrop of the Spencer Coal at water-level across the strike to the Kantner Coal is 1160 feet.

Little Diamond Coal Slope.—In this slope the dip is from 30° to 40° S. The course of the Little Diamond water-level gangway is about S. 80° W.

The Kantner Coal has been worked E. through to West Branch: the coal there rolls over in the hill even to a S. dip.

Heilner's Kantner Drift has a very steep N. dip; it was worked W. and round the point of a basin into the S. dips of Spencer's Slope coal.

ANTICLINAL FLEXURES AND THEIR COALS ON WEST-WEST BRANCH.

Griscom's Axis and Mines.—The anticlinal flexure of *Griscom's Land*, axis P, after passing through the disturbed measures in the railroad-cut N. of Llewellyn, takes the hill or ridge which lies next N. of the turnpike road, and thus ranges on to Muddy Branch. The same hill may embrace the small axis just N. of Llewellyn, if indeed it extends so far Westward. It would seem to be very nearly in the prolongation of that of the Big Lick Mountain. I am disposed to regard the anticlinal next N. of Llewellyn as belonging rather to a chain of lesser axes than to one continuous one. Griscom's axis seems to pass the Muddy Branch near the outcrop of the Lewis Coal (or possibly it is that further North), and ranges thence Westward to the Swatara, where it is the second axis N. of the turnpike. This last named we have traced for about half a mile further

Westward along the crest of the hill, but we could not discern any proof of it on or near the Donaldson Road at the E. tributary of Middle Creek, from whence I infer that it there expires.

Griscom's axis seems to dip at the pump-slope Westward, and brings together there the North and South-dipping parts of the coal, for it has not been found in shafting Westward of that point. This axis crosses the Minersville Road, about 400 yards E. of Frain's house, at a ridge on the road where the two outcrops of the Slope Coal are from 100 to 150 feet asunder. The North-dipping part is vertical all the way, the South-dipping somewhat flattish. The strike of both is regular from a point 100 yards E. of the pump-slope, but at the pump-slope the North-dipping part of the coal trends N. 55° E., and the South-dipping trends due E.

This axis, traced Westward a quarter of a mile, leads us to a ravine in which is a slope on a South-dipping vein nearly 100 yards to the S. of the saddle. This new slope has been sunk in the coal 45 yards. Near the outcrop it is 6 feet thick, then it jumps two or three times downwards and upwards, and at the foot of the slope is only 4 feet thick, soft, and not workable ; dip due S., and strike E. and W. ; average dip from 40° to 50°. This axis prolongs itself Westward, and passes the West-West Branch near the swamp at the Railroad Bridge. It seems to be the anticlinal of the hollow South of the South Peach Mountain outcrop. A hard coarse sandstone rises in the axis on the crown of the ridge, and is seen on the Minersville Road : thence it runs to the N. of Weaver's.

Red Mountain Axis.—On the West-West Branch below Llewellyn we find this axis indicated in the dips at the Salem Colliery, worked in 1852 by Heilner & Co. Here we have proofs of a small anticlinal and synclinal flexure on the S., in the position of the outcrop of the Salem Coal, and a chief or principal fold in the strata a few hundred yards to the N. of this, in a longitudinal or E. and W. ravine dividing two ridges, in the S. of which is the Tunnel Coal, and in the N. the Gate Coal. This main axis seems to be a folded one, for the steep dip of the Gate Coal, which is as much as 65° or 70°, succeeding immediately the gentler dips of the Tunnel Coal (45°), implies strongly the presence of an inversion on the N. side. It is possible that the *Little Lick* axis prolongs itself as far as the West-West Branch, for at about its usual position N. of the main anticlinal we have steep dips of 62°, and in the first exposures S. of Llewellyn, as if the strata of this belt were likewise overturned. Possibly they belong to the inverted rocks which include the Gate Coal, but the distance between them is greater than is generally occupied by the breadth of a perpendicular or inverted set of strata in this region of closely-approximated anticlinals.

The Little Diamond Coal (of Wolf Creek, or Big Tracey of Norwegian) barely reaches the water-level in the basin included between the broad arch of Primrose Hill on the E. side of West-West Branch and the saddle from 600 to 700 feet N. of it ; but in the small basin north of this N. axis it does not descend to the level of Patten's Valley. (See Section on West-West Branch.) The Red-Ash Cockle's Coal descends to below water-level in Patten's Valley, and soon rises again in a flat basin ; then arches over the small N. axis, and again basins under the little trough of the Little Diamond Coal, to reascend as Britton's Coal, the equivalent of the Phœnix Upper Slope Coal, worked by Miller on the next S. dip.

Considering the Phœnix Upper Slope Coal, or Little Diamond of West-West Branch, as the Big Tracey Coal, which it unquestionably is, the small coal next beneath it is the equivalent of the Yard Coal of Mill Creek, and the 4-feet-thick seam under this again is the Peacock Coal of the

same district. By this tracing we learn that, while the capping-rock of the Little Tracey Coal has in reaching West-West Branch grown less pebbly and massive than at Mill Creek, the subjacent hard stratum which underlies the Big Tracey Coal, and that above the Peacock (Cockle's Red Ash), have both of them become considerably coarser and more conglomeritic. The uppermost of these, in its higher layers, is in fact a true Pea and Nut-conglomerate. It is readily recognised by the well-smoothed and ovoid form of its pebbles, and the sparse manner in which those are disposed through the sandstone material of the rock, making it a true plum-pudding stone.

In the very centre of the wide gentle arch of the Primrose anticlinal, on the E. side of West-West Branch Valley, we find, at 20 or 30 feet above the bed of the valley, the well-marked conglomerate which caps the so-called Big Diamond of Wolf Creek. The coal lifted above water-level on the W. side of West-West Branch Valley, and there mined in Miller's North and South Mines, is here on the S. side scarcely elevated above the flats of the valley, showing quite a marked subsidence Eastward of the whole saddle.

MILLER AND STAHL'S PHŒNIX COLLIERY.

The drift is on the North Vein, and the dip N. is steep at the entrance of the drift, but as the gangway extends W. the dip becomes much *less*. It was driven W. about one mile. This N. bed is in the round-backed hill directly S. of the first anticlinal S. of Forestville, or axis M. The North Vein is 7 feet thick, with a 2-feet coal 2 or 3 yards above it. S. of this hill is a valley, and in the hill next S. is worked what is called the South Vein, which here basins, so that the gangway runs for a part of the way just along the bottom of the trough. This coal is regarded by some persons as the same with the North Vein. It, like the latter, is about 7 feet thick, with a 2-feet vein a short distance above it.

A few hundred feet S. of the Company's Store is an old drift on what is called the Peach Mountain Coal. This is merely the continuation of the Peach Mountain Basin prolonged from Minersville.

The anticlinal axis occupies the hollow between the round-backed hill, and the next one on its S. On the opposite or E. side of the valley, the axis just mentioned seems to be much feebler, serving only to give a gentle undulation ; but this requires careful examination. There is here apparently a long low flat arch of conglomeritic sandstone.

As we proceed Northward, approaching Britton's Colliery, we have S. dips, and farther still a decided anticlinal. This is admirably exposed at a higher level on the hill-side along the railroad leading to Britton's Drift. Here we have somewhat massive and flaggy sandstone, with conglomerate displaying a gentle S. dip, becoming then flat, and afterwards turning into a somewhat steep N. dip of say 45°. The direction of this anticlinal would carry it along the N. base of the round-backed hill above referred to, which is well marked on the Map. The coal worked by Britton lies above this sandstone, and is said to be the same as the North Vein on the other side of the creek. It is undoubtedly *inferior* to the Peach Mountain. Mr Berryman says he worked up the North Vein over the saddle into the South Vein ; the three dips are therefore *certain*.

LLEWELLYN.

The hill or ridge S. of the Pottsville and Tremont Road, and S.E. of Llewellyn, contains three coals. The lower coal, with dip 60° S., is 6 feet thick, slaty, and is the same which shows soft coal and dirt 12 feet thick W. of West-West Branch: the second is a thin coal, 3 feet thick: the third is a large bed of coal, 8 feet thick, soft and shelly; it dips from 20° to 25° S. and its outcrop is a short distance N. of the Northern brow of the ridge. This ridge extends across West-West Branch to that of Klauser's fields.

The main Gate Ridge is far to the S. of it. It appears to be a monoclinal ridge; its crest is formed of a coarse sandstone, dipping rather steeply S. It coalesces Eastward with the ridge next S. of it on the N. and S. trend of the turnpike; they also unite W. of the Muddy Branch in a high ridge. The true Red Mountain or Gate Ridge is still S. of this high one, and is split by a longitudinal hollow Westward of Heilner's Salem mines, caused by the denudation on the anticlinal.

SALEM COLLIERY, BELOW LLEWELLYN.

The veins worked in 1853 were only—

The *Salem Vein*, which had a slope on it, 150 yards down, on dip 45°.

The gangways were driven E. 250 yards, and W. 1400 yards. The only vein worked had 3½ feet of coal; the benches here are not regular. The top is generally 3½ feet thick; there is often a bottom bench of 1 foot in depth, underlaid by a sandstone, as at Port Carbon. They expect to take 20,000 tons this year from the Salem bed.

The *Faust* Coal had not been worked; it was found not to be good in the drift. The Salem Coal had been shafted extensively on the Swatara, but is faulty. A tunnel running Northward 70 yards from the Salem bed was intended to cut the Faust Coal; the vein there was about 4 feet thick, but very faulty.

The Faust Coal had not been opened at Swatara. It has a N. dip of 55°, and seems to be the Salem; it *does not crop out on the mountain.* There are 36 yards of cap rock.

The *Rabbit Hole* Coal has here 3 feet of coal; it had not been worked here, or anywhere to the Westward. This is certainly the Salem, on its final rise to the outcrop which is shafted on the hill.

The *Tunnel* Coal is here about 6 feet thick; the bottom layer 1 foot of soft mining, and a 5-feet top bed of good coal. It has been worked 1400 yards Westward, and not here to the Eastward, as it has been at Crescentville; it is generally in good condition on West-West Branch.

The *Black Mine* Coal has here a thickness of about 5 feet of coal; its benches are very much the same as those of the Tunnel Vein. It had not been worked hence Westward; but twelve or thirteen years ago it was mined some 500 yards Eastward by Samuel Heilner. The gangway ended in a rock-fault.

The *Selkirk* or *Lawton* Coal was not mined here at all: it was shafted on, and proved too poor to work.

The *Gate* Coal was here mined to the Westward 500 yards to the line of this Estate, and driven Eastward from Little Muddy Branch. Another seam was worked from 500 to 600 yards, to meet

the line. It has therefore been worked above water-level through to Little Muddy Branch. It has 4½ feet of coal, all in one bench; has 3½-feet clod on the top of it. This upper layer, or "clod," is a soft slate at Muddy Branch. The dip here at West-West Branch is 65°, but becomes 40° one mile to the W.; and the clod is there gone, so that, the roof being good, the coal is easily worked. This clod is a rotten slippery slate, and will sometimes run like sand, making the coal difficult to mine. It would seem not to be a true shale; the fact stated that in the same gangway the vein flattens to 40°, and has a good slate roof, looking much as if the coal is not an overturned bed at all.

The *Little Gate* Coal was not even found here. The shafts on the ridge are certainly not on it.

The *South Salem* Coal has been worked W. 200 yards, but was soft and faulty, and not worth mining; its thickness was 4 feet.

A tunnel goes from the Salem Coal, at a point 700 feet W. of the foot of the Slope, Northward towards the Faust. It had been driven 70 yards, and at a depth of 35 yards it turns over into a N. dip about 50°: the remaining 35 yards is all through N. dip. The measures are chiefly sandstone, with a little slate. The tunnel was expected to cut the Faust Coal at a depth of 65 or 70 yards, but the North-dipping strata have disappointed all calculations.

The actual axis near the Gate Coal has not been detected, and it is even doubtful if the Gates are not here true South-dipping coals. Perhaps the axis lies between the two ridges of Red Mountain.

BRANCH DALE COLLIERY (McDONALD'S), MUDDY BRANCH.

At the tip of the new slope on the *Lewis* Coal there is a saddle which has been traced to Swatara. The distance from the Lewis Coal saddle to the Spohn Coal Slope, on the S. dip, is 664 feet, on a N. and S. course. The axis of the Lewis Coal rises Westward. The coal saddles it, in some places, on higher ground, and at Swatara the beds are 335 feet apart. The Lewis Coal Slope descends into a water-level drift; the dip is from 30° to 32°. The coal is 9 feet thick, and when regular, is in three benches; the top one is from 4 to 5 feet thick, with 1 foot of Bone Coal.

The *Spohn* Coal is in all 6 feet thick; it has a bottom bench from 15 to 18 inches thick, and bone 18 inches; the top bench is from 3 to 3½ feet of good coal: it was in fault for 800 yards, from the introduction of a sandstone in the position of its top bench. It runs from the slope 300 yards E., and 500 yards W. The Spohn Coal has a rock top, with 3 feet of slate between it and the rock.

The Spohn Coal saddles at the slope; it is about 150 yards from outcrop to outcrop. The North Spohn is under the Breaker. These outcrops separate on going Westward 600 yards; then they contract, and at the Swatara they unite at the water-level. On the water-level gangway from Muddy Branch, we met the saddle brought down about 250 yards W. of the Swatara Road. The Lewis and Spohn Coal saddles, at the road on the E. side of Swatara, are not 20 feet apart. The N. dip of the Lewis Coal is here 6 feet thick, and the sound part is an excellent coal.

The synclinal axis of M. Weaver's Peach Mountain Coal is visible on the road just E. of the Little Inn, at the intersection of the Muddy Creek Railroad and the Wagon Road.

LOWER OR LITTLE MUDDY BRANCH, RED MOUNTAIN AXIS.

Here the flexure appears to be single, and has a perpendicular dip on its N. side, and a dip of about 40° on its S. The *Northern* or *Little Lick* axis seems to hold its place N. of the main anticlinal of Red Mountain just mentioned, for at Bettinger's North Mine, near the sawmill on the Muddy Branch, we see the evidences of a saddle in this very line. That there is an axis here is certain, for we have all the indications of a synclinal in the rocks S. of the mine in the cut on the railroad. This cut exhibits S. dips of 30° or 45°, meeting dips seemingly inverted of 80° S.; and S. of this apparent synclinal is a long narrow longitudinal valley, very nearly in the range of the Little Lick anticlinal, which is in all probability the line of the anticlinal connected with the 80° S., or overturned dips on its N.

BETTINGER'S MINES, LITTLE MUDDY CREEK.

The coals opened and worked at Bettinger's or Dundas's Mines on Little Muddy Branch are as follows:—

The Gate Vein, so called. This occurs immediately N. of the anticlinal axis. It is 5 feet thick, and underlaid by 6 feet of slate. The dip is not regular, being in one place flat, and elsewhere in the same dip nearly perpendicular, and again steeply S., and overturned.

Another Gate Vein, between 200 and 300 feet N. of the first, and dipping also perpendicularly, is 4 or 5 feet thick between slate and slate, but contains only 18 inches or 2 feet of coal.

A coal-bed just S. of the anticlinal axis, apparently the S. dip of the Gate Vein, has been worked E. to the line of the estate, and W. about 1400 yards, but it proved faulty nearly all the way. Above it occur two other coals, and then another, called the Black Mine bed, not worked. About 270 feet S. of the last occurs the Tunnel Vein, so called, here mined by a slope-pit. This is the fifth coal ascending from the axis.

Over the Tunnel Vein, at a horizontal distance of 180 feet, lies the Rabbit Hole bed, faulty at the surface, but reached below the water-level by a tunnel driven S. from the Tunnel Vein. To this succeeds the Faust Coal, and beyond it lies another. These South-dipping coals all incline S. about 40°; their strike is S. 80° W.

The Tunnel Coal had been mined, in 1853, W. from the E. line of the estate about 500 yards. It is generally sound, though its thickness is from 4 to 6, or even 7 feet. The Black Mine Coal was not worked. It is overlaid by a pebbly sandstone.

The York Tunnel (*Deep Run*).—This tunnel has been driven N. to the Big Diamond, and the coal has been mined towards Charles Miller's Slope. It is indeed the same bed with that of the slope. About 35 yards further the tunnel cuts the Anderson Coal, and 195 yards still further the Kear's Coal.

COALS ON SWATARA.

About 100 feet N. of the junction of the Swatara Railroad and the Tremont Turnpike, we see the outcrop of a South-dipping grey conglomerate exceedingly like the rock of the Gate and Lewis synclinal trough on Mill Creek above the *Sandrock series*—viz., the *Faust* rock.

It is quite clear from all the evidence that the coals *above* the Egg-conglomerates do not pass

W. in the *Fisher's Basin* beyond Middle Creek, but the lower set, the five inferior beds opened by Mr Werntz on the S. dip of the mountain, run on far to the W., passing behind the Donaldson Mines, and so on to Klinger's Gap, where he has opened all of them. These five lower coals must run on E. a certain distance, but it is doubtful if they are all above water-level at the Swatara Falls axis.

It was, at the date of our researches, a point of much interest to ascertain the place on this anticlinal E. from Swatara Falls, at which the higher strata conceal altogether the upper great Egg-conglomerate. Is it not somewhere between Swatara Falls and Edwards and Morgan's Tunnel? If the upper or Big Coal of Fisher's Basin at Swatara is really the lower or White-Ash Coal of New Mines, as some aver, what is this coal called when it reaches Forestville? Is it not the coal cut in Morgan's Tunnel at the head of Muddy Branch, or the Black Valley Coal of Forestville? It is of some local importance to ascertain where it gets over the Swatara Falls anticlinal.

The Big Vein may be known by its being composed of 6-feet coal, 4 feet of it good; of 1½ feet Bone coal, with 4 inches slate in it; and of 2 to 3 feet clear excellent coal. One of these benches is a reddish-ash coal. The next lower coal-bench or small bed, 1 to 2 feet thick under it, is separated by a rock and 3 feet of Bony coal.

SWATARA COLLIERY, D. P. BROWN & CO.

There are three coal-beds opened here. The middle, 5 feet thick, is a good Grey-Ash coal. The upper is from 10 to 12 feet thick; it averages 7 feet of coal. It has a pinkish ash. There is a third lower seam, which lies not far above the Pea-conglomerate, which rests on the large upper Egg-conglomerate. It is a thin bed.

The 5-feet seam has been driven W. on a N. dip 300 yards. The upper one the same distance on a S. dip. Of this the lower bench is red, and the upper is pinkish ash. At the drift-road, 100 feet above the stream, the coals basin by a sudden or perpendicular reascent of the strata to the surface. The upper of these coals is capped by a singularly rough conglomerate. It is a bed of true Egg-conglomerate, in some places from 8 to 10 feet thick; in others not more than 6 feet, overlaid by shale and sandstone.

MIDDLE CREEK.

On the E. side of Middle Creek N. of the Arch Rock saddle, or in Fisher's Basin, three coals have been opened, all with flat N. and S. dips. Indeed, the coals do not cross the creek Westward:—

1. The Little Grey Coal is shafted in the centre of the basin.

2. A gangway has been driven on the Donaldson Coal in the centre of the basin, at a point facing Middle Creek; it dips gently N. It was at first soft and faulty in the gangway; what its present condition is, we are not informed.

3. The upper coal is the Lomason or Big Coal of Donaldson. It has been mined. The space between the two outcrops of this coal is at least half a mile.

The Grey Coal (the lowest) basins just at the level of the creek, the middle about 50 or 60

feet above the water-level, and the upper 80 or 90 feet above the same horizon. At Fisher's Basin the same three coals have been opened, and partially mined. The Grey bed had 4 feet of good coal.

The upper large coal, or the Big Coal, so called, has not, in Fisher's Basin east of Middle Creek, the coarse Egg-conglomerate over it which we see at Brown's or Swatara.

There are five coals shafted on the mountain on the N. side of Fisher's Basin N. of the Egg-conglomerate or Big Rock, in strata lower than the Grey Coal. Of these, the two lower contain but 6 inches of coal.

The third is 11 feet thick, but soft. Perhaps this is not its true size, as it was but 7 feet in the bottom of the shaft.

The fourth was a 6-feet coal in the shaft, but had not much good coal in it. It was soft and squeezed.

The fifth was soft coal, 2 feet thick, but squeezed, with a conglomerate above and below it. It is seen about 1200 yards N. of the Big Rock. The dip of all these is about 30° S.

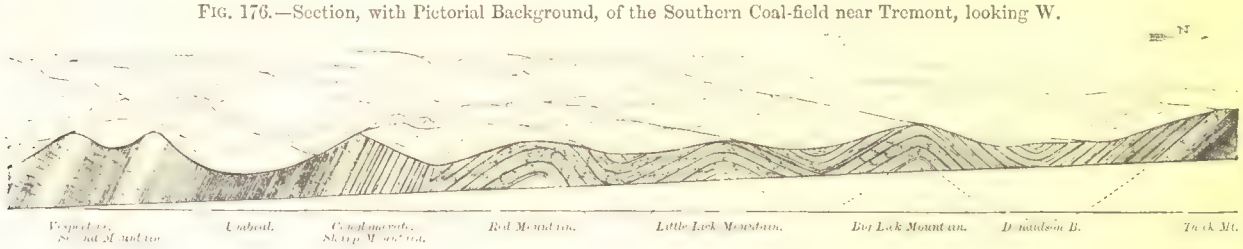
CHAPTER X.

COAL-FIELD BETWEEN MIDDLE CREEK AND THE FORKING OF THE BASIN.

As stated in our general preliminary description, the S. coal-field separates Westward into two branches, the N. one being entitled the Bear Valley, or the Wiconisco Basin, and the S. the Dauphin Basin. The place of bifurcation is the kettle or cove at the E. head of Williams' Valley, where the lower conglomerates of the Coal-measures expand in the broad elevated anticlinal table-land of the Little Lick Mountain forking into two monoclinal crests to form the Lick Mountain of the Bear Valley, and the fourth mountain of the Dauphin Basin. Between Middle Creek of Swatara and this place of forking, the general structure of the coal-field is rather simple. Nearly all the undulations which complicate and diversify its structure in the regions E. of Middle Creek, have passed Westward out of the coal-field into the spurs of Mine Hill or West Broad Mountain, and there remain but the three wide and steep flexures of Big Lick, Little Lick, and Red Mountains, diverging Westward with the spreading of the basin prior to its bifurcation. The structure of this portion of the coal-field is well disclosed by the natural section furnished by the valley of Good Spring Creek, which intersects all the three anticlinals. After the sufficiently elaborate description of these several flexures, and their effects upon the strata, it will not be necessary in this chapter to trace again their course, or especially to refer to them, except in connection with an enumeration of the coal-seams which they severally expose. Before proceeding to an account of these, the attention of the reader is requested to the annexed pictorial Section, designed to represent both the geological structure of this W. end of the main coal-basin, and the strikingly close connection which prevails between this structure and its topography, external features or scenery. It is drawn as the district would appear from a balloon suspended in the air E. of Good Spring Creek, and N. of the crest of Red Mountain. The diverging crests of the three anticlinal ridges are seen stretching W. to insulate respectively the Donaldson or Good Spring Basin on

the right, and the Swatara or Dauphin Basin on the left, while the Kettle is distinctly shown in the middle of the picture in the distance, itself forking round the high anticlinal knob of Peter's and Berry's mountain. It brings out distinctly the origin of every valley and mountain-crest within the district, showing the valleys to have been excavated in every case in the softer strata, and the ridges and crests to be simply the more projecting waves and ribs of the harder rocks, not quite so deeply eroded. It serves to illustrate, even to the minuter features of the general landscape, the intimate dependence of scenery upon the two geological elements, altitude or dip, and relative softness and hardness of the rocks. This sketch displays the differences of form and depth between the four synclinal troughs into which the basin is subdivided by the three anticlinals, showing the oblique or folded shape of the more Southern one, the inverted dip of all the strata S. of it, and the normal curvature of the other three. The two central basins—that between Red Mountain and Little Lick Mountain, and that between the latter and Big Lick Mountain—are seen rising and heading out from the plateau at no great distance from the Section; whereas the folded one at the base of the Sharp Mountain, and the other deep one at Donaldson at the foot of the Thick Mountain, are beheld stretching far into the distance bounded by their well-defined mountain-barriers.

FIG. 176.—Section, with Pictorial Background, of the Southern Coal-field near Tremont, looking W.



1 bird, Rausch Gap. 2 birds, Swatara Gap. 3 birds, Panther Head.

BASIN OF DONALDSON, OR BASIN *NQ*.

It was shown, in treating of the N. synclinal belts at the Swatara, that neither the Peach Mountain axis O, nor the Branch Dale flexure S. of it, appears in much force at their intersection by that stream. It is probable that they either expire altogether, or become very flat, before reaching the meridian of Donaldson. Indeed, there are no indications of either of these flexures in the ravine of Coal Run W. of Middle Creek. It has been also intimated that the axis N of the Dripping Arch of Middle Creek, the N. boundary of this synclinal belt, rises steadily W., closing up Fisher's Basin N. of it, and merges itself in the gentle S. dips of the long sloping S. shoulder of the Thick or Broad Mountain N.E. of Donaldson. It would thus appear that, if not from Middle Creek, at least from Coal Run westward, the trough is a simple one of a normal synclinal cross-section, wherein the S. dips of the N. side are of an inclination averaging 45°, while the N. dips of the S. side are as steep as 75° or 80°. The position of the synclinal axis is therefore far towards the S. side of the belt; indeed, it passes through the village of Donaldson, and thence Westward along the immediate valley of Good Spring Creek. Under this form, and with little variation in breadth or depth from Donaldson westward, it extends with remarkable straightness as far at least as Klinger's Gap, and without much contraction, indeed, until it passes the watershed between the East and West Bear Creeks.

Coals.—At Middle Creek the number of coal-seams within the basin *N Q*, notwithstanding the probable presence there of the axis P, must be very considerable, and it is still large, perhaps quite as great, at Donaldson, and for some distance further W. It will be seen, upon inspecting the Section of Big Mountain and of Big Lick Mountain, near Donaldson (see Plate III. of the long coal Sections), that besides the entire series of White-Ash coal-seams outcropping in the flank and summit of the Big or Thick Mountain, the basin there embraces an extensive group of Red-Ash beds, the total number opened for both classes, thick and thin, amounting to seventeen or eighteen. At least five of the Red-Ash group have been exposed by proving and mining, in concentric saddles, in Big Lick Mountain. Inasmuch as the coals of the deeper central line of the trough lie under a deep covering of wash or diluvial matter, and have never been opened, we may add at least two or three to the previous enumeration, and count the whole number at twenty: of these, five or six are of large dimensions, and are susceptible of being profitably wrought. The section already referred to, and the profile of the Donaldson Tunnel, here inserted, will furnish the reader with the dimensions, the distances apart, and the dips of all the coal-seams at present exposed here, and will serve as a key for estimating the contents and structure of the basin both E. and W. of Donaldson.

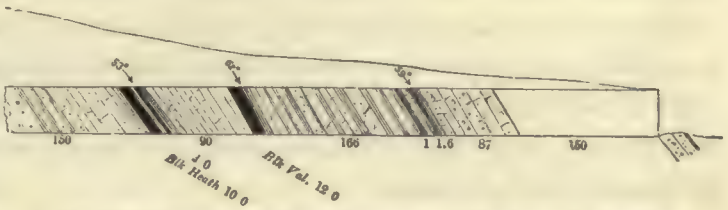


FIG. 177.—Tunnel in the Thick Mountain N. of Donaldson, looking E.
1 *inch* = 200 *feet.*

Thick Mountain Tunnel and Drifts.—The coals here are,—

1st, The Gardiner or Twelve-feet Coal, or Black Valley Coal, worked on the E. and W. sides of the valley; it is quite good coal, but sometimes soft—lies in one bench. The gangways are straight. It has been mined W. one mile, but not worked E. so far; it was cut in the Thick Mountain Tunnel.

2d, The Black Heath Coal is 8 feet thick, and in one bench; it has been mined E. and W. About one mile W. the gangways are straight. It is worked on the W. side chiefly; it also was cut in the tunnel.

3d, The Iron-ore Coal was shafted upon, but was not worked: there was no good coal in it: it is 2½ feet thick, and about 150 feet N. of the Black Heath Coal.

4th, The Big Coal is 16 feet thick on the average; it occurs in two benches of good coal, though somewhat faulty. It has been mined E. half a mile, and W. more than one mile. The gangways are regular and straight.

5th, A ten-feet coal is mined E. 1000 yards, and W. the same distance, and is in one bench. On the E. side the coal is good; on the W. it is faulty for 700 yards.

The Big Diamond coal, S. of all these, is opened and worked by a drift; it has from 3½ to 4 feet of pretty good coal; it was mined but a short distance, and only to the W.

BASIN OF BIG AND LITTLE LICK MOUNTAINS, OR BASIN *Q R;* ALSO LITTLE LICK MOUNTAIN.

The synclinal belt embraced between the two Lick Mountains may be regarded as the prolongation Westward of the very long but somewhat undulated trough of coal strata immediately N. of the Gate Ridge; it is only at Swatara, or perhaps more truly at Middle Creek, that it assumes an independent synclinal structure in the development of its two bounding anticlinals: these seem slightly to diverge going W., making the basin widest about the meridian of Rausch Creek, where, however, it is by no means deepest. The rapid ascent Westward of the anticlinal

axis of the Little Lick Mountain, by successively lifting out in that direction the lower Coal-measures, produces, in conjunction with a similar though more gentle rise of the Big Lick axis, a progressive shallowing and flattening of the basin, until at the sources of Rausch Creek it becomes merely a high mountain-trough on the N. slope of the Lick Mountain. From this point—namely, the head of the "Kettle"—it now rapidly contracts and shoals, until, opposite Klinger's Gap, it is little more than a mere broad shoulder or expansion of the same mountain, embracing only the very lowest thin White-Ash coals, alternating with the coarse conglomerates. The following notes of the coal-beds opened and mined at the Good Spring Gap in Big Lick Mountain, and in the N. flank of the Little Lick Mountain, W. of Tremont, will sufficiently exemplify the structure and resources as hitherto developed of the two borders of this basin. Its central deeper portion is almost wholly unknown; but taking its width and the steepness of its bounding anticlinal flexures into consideration, with the farther circumstance that neither of these anticlinals lifts either of the White-Ash coal-seams to the surface till we pass a good distance W. of Tremont, it is obvious that it must be a very capacious trough, holding, in all probability, a greater depth of Coal-measures between Good Spring Creek and Rausch Creek than the Donaldson Basin itself.

BIG LICK MOUNTAIN ANTICLINAL.

This very straight and persistent axis may be traced E. from Donaldson, by the dips and the topography, the whole distance to the Swatara. It is well seen in the dips newly exposed on the Middle Creek Branch of the Mine Hill Railroad; again in the cuts of this railroad, in the same spur further E.; and it is very striking again, in its anticlinal arch, in a cut on the Swatara Railroad, only a few hundred feet N. of the turnpike road. Eastward from the Swatara we could not follow it; but there is good reason to suppose that it is declining and fading away in that direction, inasmuch as we find only S. dips under Llewellyn, and immediately S. of this village, in the belt into which this axis should manifestly be prolonged, if it runs so far.

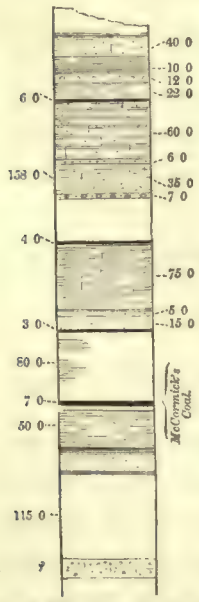


FIG. 178.—Strata in Big Lick Mountain. — 1 *inch* = 200 *feet.*

Coals in the Gap of Big Lick Mountain, Donaldson:—

1. The outside coal on the S. dip is from 6 to 10 feet thick—it has been driven 600 yards or further.

2. The next bed N., also on the S. dip, is 4 or 5 feet thick—it has been worked E. three-fourths of a mile.

3. The small coal has been driven E. only a few yards.

4. A fourth, called McCormick's Coal, is from 1 to 10 feet thick on the S. dip. It was driven 600 yards E. at the date of our observation.

5. A small coal—was mined in 25 or 30 yards. To this succeeds the saddle.

The N. veins are very nearly perpendicular. The equivalent of No. 4, North-dipping, was mined Eastward one-third of a mile, and was about 10 feet thick. The equivalent of No. 2 was also worked Eastward one-third of a mile.

On the W. side of the valley of Good Spring Creek, No. 4 was worked on a S. dip by McCormick and Clark—it was mined in Westward 1 mile; its dip is 65° S., and not less to the end of the gangway. The coal is of a red ash. On the W. side, No. 2 was worked in on the S. dip about 400 yards. Its dip is 65° S. It is a good Red-Ash coal.

LITTLE LICK MOUNTAIN.

The Little Lick Mountain, W. of Tremont, contains three anticlinal flexures, the most Southern of which is obviously the chief one, being traceable to the bold arch of the Egg-conglomerate visible at Rauschville. All of these saddles descend rapidly Eastward: the middle one is apparently the shortest; the two outside ones, especially the most Northern, exhibit very steep N. dips. At the date of our observations there were five separate beds of coal of workable dimensions, proved and partially traced, and the upper or more external of them mined to a considerable extent. In descending order their dimensions are 4 feet, 4 feet, 7 feet, 5 feet, and 7 feet. The getting access to these coals has not been an easy matter. To tunnel into them from a low level on the S. side of the mountain would have implied a large expenditure, as the S. dips are comparatively gentle, and the requisite tunnels there must be long. The greater steepness of the N. side of the hill, and closer proximity of the North-dipping coal-seams, naturally led to their being first entered by tunneling from that quarter; but this resulted, as might have been anticipated, in much disappointment. As usual, the flexures having one gentle and one perpendicular dip, the perpendicular strata have been found to be much squeezed, and the coals therefore—namely the second 4-feet bed, and the 7-feet seam beneath it, and the next coal below this again—have all been found so faulty as scarcely to repay the cost of mining. The method of entering these coal-beds has been by short tunnels, some from the exterior, others from within gangways already cut, but all planned to reach the next interior coal near its place of saddling or arching over and round its anticlinal axis, the object being to command as soon as possible a double line of gangway, or rather to get round the point or nose of the West-dipping saddle in the South-dipping portion of the coal-bed. This mode of entering the mountain—assuming a long tunnel from its S. side to be too costly—appears to be, after all, the most feasible, and would have proved eminently successful, if the mountain, in place of containing three saddles, possessed but one. In that case the gangways in the South-dipping coals could have been extended indefinitely to the W., but the existing more complex state of things will turn these gangways round the ends of the synclinal basins and Eastward into North-dipping strata, until, by successive windings through comparatively sound South-dipping coal, and very faulty soft perpendicular-dipping coal, they at last reach the S. side of the main Southern axis, along which they may proceed without further check. Such being the inevitable conditions attending the mining of these concentrically enclosed coals from the N. side of the mountain, it is obvious that to extract the coal from at least the S. part of the ridge, the method by tunneling from the S. would be altogether the most feasible.

Spangler's Four-feet-thick Coal is penetrated by a tunnel near the point of its anticlinal flexure at Tremont. The tunnel enters the strata from the N. side of the ridge, running 145 yards S. 64° W. in the outside coal-bed; it then turns abruptly towards the S., and cuts slate and sandstone through 121 feet to the other 4-feet seam, reaching this bed 92 feet W. of the point of its saddle. Another tunnel farther to the W., at a higher level, cuts Spangler's Four-feet Coal, and reaches the 7-feet seam inside of it, very near the point at which this seam in its turn saddles over its axis at the tunnel-level; and a third tunnel, 80 yards in length, starts from the gangway of the N. dip of the 7-feet seam, and, like the rest, directed S., cuts the measures between the 7-feet bed, and the coal next inside of it, which it meets in a similar position, namely, a little W. of the point at which it swings over the declining anticlinal axis.

BASIN OF LITTLE LICK MOUNTAIN AND RED MOUNTAIN.

As intimated in a former chapter, this synclinal trough expands rapidly Westward from the Swatara, and rises as it expands, until it lifts itself out from the broad plateau around the S. side of the Kettle. It is intersected by the valley of Good Spring Creek at Tremont, and by that of Rausch Creek, 2 miles further W. From the Middle Creek Railroad at Swatara, to Tremont, the developments within this basin are very few, and its structure is obscure; but W. of that village its contents are better defined, the topographical features being more distinct, the mining explorations in Little Lick Mountain and in Red Mountain, at the gaps of Good Spring and Rausch Creeks, revealing to us some of its coal-seams. It has been already stated that the Red Mountain or Gate Ridge discloses at Good Spring Creek not fewer than eleven seams of Red-Ash coal dipping N. into this basin at a very steep angle; and in our previous description of the Little Lick Mountain, the N. side of the basin, or the S. flank of that ridge, was shown to contain at least six outcrops of coal-beds of workable dimensions. (See Section of Red Mountain and the annexed vertical column of North-dipping beds.) The probability is, that the total number, big and little, at Good Spring Creek, is from thirteen to fourteen, for the synclinal axis of the basin cannot be far N. of the base of Red Mountain. This line of lowest depression of the trough does not range centrally along the belt, but maintains a direction very nearly parallel to the anticlinal or crest-line of Red Ridge all the way to Rausch Creek, and even to Lorberry Creek, as may be seen by inspecting the Rausch Creek section in Plate III. The North-dipping coals of the S. side of the basin in the N. side of Red Mountain, maintain their steep or nearly perpendicular dips as far W. as Rausch Creek, beyond which they flatten as they pass the head of Lorberry Creek, to join the South-east-dipping corresponding strata of the W. end of the basin. From Good Spring Creek the coal-beds rise out towards the W. in successive concentric basins or spoon-shaped troughs, some of which are even vaguely indicated in the topographical features of the valley. This structure is eminently adapted to a successful mining of the thicker coal-seams, since shafts or slopes, sunk in the vicinity of Tremont, will drain extensive fields of gently South-dipping coals all the way to Rausch Creek. The Red-Ash Coal-measures occupy the entire breadth of this basin as far as Rausch Creek, excepting a wide triangular area N. of the axis on the high table-land of the Little Lick Mountain, where the White-Ash coals, down to the coarse Egg-conglomerate, at the anticlinal of that mountain, spread themselves out in a very gentle Southerly dip. On Rausch Creek the total number of coal-seams left within this basin would appear to be about seven. Three of these, including Kechre's and Wells' coals, at the passage of the Red to the White-Ash groups, are seen spanning the anticlinal axis of the Red Mountain above the water-level, and reascending on the N. side of the synclinal, with a S. dip of not more than 20°. Next beneath them occurs the Big Coal, so called, identical probably with the large seam of Donaldson. This is some distance below the water-level of the valley at the Red Mountain anticlinal axis, but on the N. side of the basin it ascends from the water-level, with a long and very gentle slope to its outcrop on the high plateau of the Little

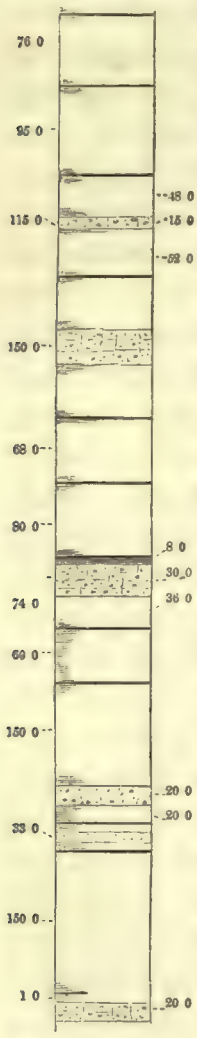


FIG. 179.—Strata in Red Mountain.—1 *inch* = 200 *feet.*

Lick Mountain. The other inferior seams may be seen dipping S. at a still lower angle, with proportionately still longer breasts as we ascend the valley to the well-exposed broad anticlinal flexure or arch of the central ridge of the mountain.

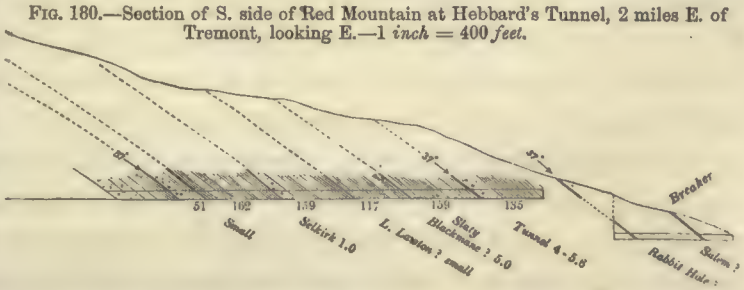
BASIN OF RED MOUNTAIN ANTICLINAL AXIS AND SHARP MOUNTAIN.

That portion of the deep straight synclinal belt or basin which lies between the Swatara Gap in the Red Mountain, and the gap of Fishing Creek in the Sharp Mountain, maintains well its average breadth and extent of Coal-measures as far W. as the notch in the Sharp Mountain by which the Swatara Creek quits the coal-field ; but from this latter point the trough commences to contract and rise by the expansion and lifting of the Red Mountain axis, until at the Fishing Creek Gap it is reduced to probably not more than two-thirds the width and depth it possesses in its Eastern half. As far W. as the Tremont Gap in Red Mountain, the South-dipping coals of the N. side of the basin incline S. at angles as high as 45° and 55°, and they retain this dip, or even a steeper one, indeed, as far as the valley of Rausch Creek. At the passage of Lorberry Creek across the basin, the S. dips become more gentle, but the strata maintain an average slope of 45° past the sources of Fishing Creek, and Westward for a great distance along the N. side of the Dauphin Basin. Except at the Tremont or Good Spring Gap, and at Rausch Creek, the coal-beds of this N. side of the basin have hitherto been very imperfectly developed by mining or experimental shafting. In the Tremont Gap, and apparently for a long distance E. and W. of it, the Coal-measures of the S. slope of the Red Mountain are, for South-dipping strata, unusually disturbed or faulty. The irregularity is chiefly of the nature of a squeezing and sliding of the coal-seams within themselves, rendering them very generally unfit for mining. This condition extends indeed all the way from Muddy Branch to Lorberry Creek, and prevails to a partial extent opposite Fishing Creek and into the N. side of the Dauphin Basin. Its cause is obvious enough : the strata of both the Sharp Mountain and of the N. slope of the Red Mountain anticlinal dip perpendicularly, and are in places even overturned ; the whole wave of the strata, from the crest of Sharp Mountain to the N. base of the Red Mountain, being in fact a greatly compressed undulation, with a steeply-inclined South-dipping axis-plane. It is obvious that in the sharp close flexing of the superficial softer Coal-measures within the trough of the less yielding underlying thick beds of conglomerate, the upper concavely-compressed materials were forced to yield in their planes of least resistance, or most feeble cohesion—that is to say, in the relatively tender coal-beds themselves.

RED MOUNTAIN OR GATE RANGE.

At Tremont the flexure of the strata in Red Mountain is, to all appearances, a single regular normal anticlinal arch, curving into the perpendicular on its Northern side, and to a dip of 45° on its Southern; but it is rather sharp, and even a little dislocated, at the crown of the arch. The South-dipping coals, in the vicinity of the Tremont Gap, are generally squeezed and faulty, the least disordered of the series being the Southernmost. This has been mined on both the E. and W. sides of the gap.

FIG. 180.—Section of S. side of Red Mountain at Hebbard's Tunnel, 2 miles E. of Tremont, looking E.—1 *inch* = 400 *feet*.



West Salem Colliery, Red Mountain, 2¼ miles E. of Tremont.—A tunnel was here driven 290 yards Southward into Red Mountain; the dip is 37° S. This mine was not successful; all but the first and last coals were in fault, and the first has a low breast. It is a singular circumstance, that, with a S. dip so gentle as 37°, the coals should be so squeezed and faulty; but such is also their condition at the Tremont Gap of Red Mountain, and indeed it belongs to this ridge as a characteristic throughout much of its W. portion. Sharp Mountain, though with overturned strata, is very regular in all this vicinity in its line of crest, and in its form; and from topographical indications, it seems to be comparatively exempt from dislocations.

Sharp Mountain Coals, their Number and unusual Position.—The S. side of this basin, or that included in the N. slope of the Sharp Mountain, embraces a thick series of Coal-measures, containing apparently nineteen or twenty separate seams, counting with the larger ones those of 1 or 2 feet in thickness. From the squeezing attendant upon the inversion of the strata above alluded to, very few of these are in a permanently minable condition, nor are we sure that we know the average dimensions of a number of them.

Throughout this Western district of the coal-field, all the lower coals lie outside, or to the S. of the main or higher crest of the Sharp Mountain, or of those hard and massive ribs of coarse conglomerate, which, at the passes of Swatara, Rausch, and Lorberry creeks, constitute the comb of the ridge. This position, so unlike that which they observe further E. in the coal-field, where the main crest of the mountain is the S. limit of all the coal, is due to a remarkable change in the type and composition of the lower Coal-measures in their extension Westward. Instead of consisting, as at Pottsville and farther E., in the lower 800 feet or so of a large proportion of ponderous and pebbly strata, interleaved with coarse sandstones and relatively little shale, and no coal-seams whatever beyond one or two impure layers 2 or 3 inches thick, the group here embraces an alternation of conglomerates and sandstones with numerous beds of coal-shale and coal itself, converting the non-productive underlying Seral conglomerate into a true coal-bearing formation, or a lower productive group of the Coal-measures. Our engraved Sections, illustrating the state of things at Swatara, Rausch, and Lorberry gaps, show that the main mass of the Sharp Mountain there includes two principal ribs or groups of thick beds of the coarse conglomerate, one adjacent to the Umbral red shale, the other further N., eight or ten coals higher in the series; it is to these two solid ribs that the mountain owes its two craggy crests, which, adjacent to the river-gaps above mentioned, are excessively torn and precipitous. The condition of things now described prevails, under modified features, throughout all the Western districts of the Southern and middle coal-fields; namely, in the conglomerate measures of the mountains bounding the Dauphin, the Wiconisco, and the Shamokin basins. A fuller description of the special phases assumed by these lower coal-strata in each of those Western districts is reserved for a future chapter, but this is the appropriate place to note that this remarkable alternation of productive coal-seams with the lower layers of conglomerate is a feature characteristic of the formation everywhere W. of the meridian of Tremont and Ashland, augmenting progressively as we advance to the W. and N.W. It may be due to either of two causes; an intercalation of beds of coal among the beds of conglomerate and sandstone constituting the barren Seral conglomerate of the country Eastward, or a thinning down of that conglomerate, and a commensurate increase of pebbly matter in the sandstones of the lower productive Coal-measures. The first assumption implies a comparative permanency in the conglomerate, and an insertion of new coal-seams between its subdivisions; the second supposes a

comparative constancy in the coal-beds, and an intrusion of conglomerates or conglomeritic matter between them. No explorations, short of extensive and connected mining and coal-shafting, will effectually determine to which cause we are to impute the change of type in the strata. Most probably it will prove to be the result of both causes combined ; for it is incompatible with a sound theory of the production of our Coal-measures, to take for granted that either class of deposits—the coal-beds or the mechanical sediments interstratified with them—are continuous over very wide spaces. I am inclined, however, to attribute the alternation of coal and conglomerate, near the base of the formation, to the actual introduction, in the Western district, of fresh beds of the former during the deposition of the latter, and to those beds thinning out and disappearing from absence of the requisite vegetable matter or conditions of vegetable growth towards the E. Among other reasons for this opinion, I will suggest in this place two apparently conclusive ones. The one is, that we may actually trace some of the valuable thick coal-seams of the Western end of the Shamokin and Pottsville basins, from station to station, Eastward, under continually-declining dimensions, until they actually thin down to insignificant layers. The other argument is, that the W. or N.W. is not the usual direction towards which the fragmentary or pebbly matter of the formation is known to increase in relative quantity and coarseness, but, on the contrary, is the very quarter towards which all the mechanical sedimentary matter of our coal-formation grows progressively finer and less abundant.

Between the red shale on the S. and the axis of the oblique folded synclinal flexure at the N. base of Sharp Mountain, we may count twenty separate beds of coal of all thicknesses, from 1 or 2 feet to 10 or 12 feet. At no one of the three gaps W. of Tremont have the whole of this series been as yet exposed, but by collating the assembled facts of the three Sections we are enabled to identify the number here specified. Nine out of the twenty occur between the main thick rib of conglomerate, at the base of the whole formation, forming the S. crest of the mountain, and the thinner bed of even coarser pebbly rock belonging to the N. crest : of these nine, five are apparently too thin for mining, and the other four are of good workable dimensions; the lowest is from 4½ to 6 feet thick, the next 10 or 12 feet, the next 6 feet, and the fourth, called here the Peacock Coal, is also thick, but of very variable size. Between the coarse Egg-conglomerate of the N. crest of the mountain, and the synclinal axis near the E. and W. reach of the Swatara, five of the eleven coals developed would appear to be thin ones, while of the remaining six the Zimmerman is 4½ feet thick ; the Umberhower, two coals higher, is 3½ feet ; the next coal is 4½ feet ; the next, a squeezed coal, is 4½ feet ; the next is 5 feet ; and the Grey Coal, the highest of the whole series, is from 12 to 14 feet.

The exact position of the synclinal axis of the basin is not clearly marked E. of the Swatara Gap, but it coincides nearly with the S. foot of Red Mountain : at the Rausch and Lorberry valleys it is well defined, and is there somewhat nearer the anticlinal axis of Red Mountain.

Throughout all this district—indeed, from the Pottsville Gap of Sharp Mountain as far as Dauphin County—the strata of Sharp Mountain are, as already intimated, tossed N. beyond the perpendicular ; in the central part of the ridge, composed of hard unyielding beds of conglomerate and sandstone, the inversion at the notches connected with the Swatara amounts, on an average, to about 15°—or the S. dip, in other words, is 75° ; but the softer and more easily crushed strata of the N. slope and foot of the mountain have been pressed down by the forward or Northward motion, at the time of the folding of the trough into a considerably more inverted or lower

S. inclination. A little study devoted to the Sections embodying our observations at Swatara, Rausch, and Lorberry gaps, will enable the reader to apprehend clearly all the interesting relations of the coals there developed, to learn what is known of their respective thicknesses and distances apart, and torecognise their degrees of inversion; it will satisfy him that this part of Sharp Mountain is scarcely more promising a field for largely-planned mining enterprise than the other portions of the same ridge further E., which I have already reviewed.

CHAPTER XI.

WICONISCO AND DAUPHIN BASINS, OR THE WESTERN BRANCH BASINS OF THE SOUTHERN COAL-FIELD.

THE great Southern coal-field forking beyond the broad anticlinal plateau of the Little Lick Mountain, the Coal rocks extend Westward in two long and slender diverging troughs, the most N. of these—the Wiconisco or Bear Creek Basin, a prolongation mainly of the basin of Donaldson—and the widest and shortest of the two, tapers to a point in the middle of Lyken's Valley, about 4 miles W. of Gratztown. Its N. barrier, the Thick or Bear Mountain, is cleft nearly to its base at Klinger's Gap, giving outlet to East Bear Creek. Its S. barrier is breached, but not to so low a level, at Bear Gap—a high notch, which discharges the West Bear Creek into the Wiconisco. From Klinger's Gap to the synclinal knob of the Short Mountain, in which it terminates, the bed of this valley rises progressively, until it terminates in that mountain-summit, and throws out its lowest coal-seams in the long spur descending Westward from it.

The Southern or Dauphin Basin, though not more than half the breadth of the Wiconisco trough, possesses nearly twice its length. There is no breach of any magnitude in its N. barrier, a high regular monoclinal mountain-ridge, which, being the fourth in order N. from the Kittatinny Valley, is commonly called the Fourth Mountain. Its S. barrier, the Sharp Mountain, retaining the narrowness and acuteness of crest which elsewhere distinguish it, is broken by six steep and narrow ravines, or high notches, which drain the waters of the basin from a high interior level Southward down into the exterior longitudinal valley of Stony Creek. The first of these, W. of the forking of the basin, is the Gap of Fishing Creek; the second, nearly 4 miles W., is the Gap of Black Spring; the third, $1\frac{1}{4}$ miles further, is called Gold Mine Gap; the fourth, $3\frac{1}{2}$ miles further W., is Rausch Gap; the fifth, 5 miles beyond, is Yellow Spring Gap; and W. of this $3\frac{1}{2}$ miles is a notch at a still higher level, which bears the name of Rattling Run Gap. From this last ravine or outlet to the end of the Coal-measures in the high narrow synclinal ridge in which the slender mountain-trough terminates, by the coalescing of its two barriers, the distance is about 12 miles. The final closing together of the North and South-dipping lowest members of the coal strata would appear to be between 5 and 6 miles E. of the little town of Dauphin on the Susquehanna. I proceed to a sketch of the Coal-measures of the Northern or Wiconisco Basin.

WICONISCO, OR BEAR VALLEY COAL-BASIN.

This, the Northern of the two Western branches of the great Southern Anthracite Basin, is bounded on the N. by the monoclinal South-dipping ridge called the Bear Mountain, a prolongation of Broad Mountain; and on the S. by a monoclinal North-dipping ridge called the Big Lick Mountain, prolonged from the anticlinal Big Lick Mountain of Donaldson. Its entire length from Donaldson's Colliery, or where Good Spring Creek leaves it, to its Western end, is about 20 miles, and its average maximum breadth between Donaldson and Klinger's Gap is a little more than 1 mile. Good Spring Creek and Rausch Creek of Swatara drain its Eastern portion; its middle division is watered by an East and West-flowing brook, which unite and pass Northward through Klinger's Gap to the Mahantango; while its Western end discharges a rivulet through Bear Gap into the Wiconisco. By these three avenues must the valuable mass of coal enclosed within this trough find egress to the markets. A railroad extends to Donaldson's Mines, and might be readily prolonged to the summit at the source of Good Spring Creek. Another railroad conveys the coal from Bear Gap to the Susquehanna, and a third through Klinger's Gap has been in contemplation.

From a point a little W. of Klinger's Gap to the end of the basin, the valley is a simple synclinal trough, the strata dipping inward on both sides at an angle of about 45°. But opposite and Eastward of the Gap, the S. side contains the anticlinal flexure of Big Lick Mountain, already described, which produces a bench or elevated flat tract on the N. side of the mountain. The N. and S. dips forming this anticlinal are well exposed in a deep and wild ravine, indicated on the Map by a stream S.E. of the gap.

This portion of the basin contains an enormous quantity of coal, and even a large amount above the water-level. A favourite idea was at one time cherished by some persons to tunnel the Southern barrier of the valley at a point a little W. of the commencement of the Section; and there can be no question that a tunnel, once properly constructed there, would give access to a most productive coal-field. This was actually begun a number of years ago. The great length of tunnel necessary to reach the best beds of coal, nearly three-fourths of a mile, and the great hardness of a large portion of the strata, would prove serious impediments, demanding an enormous outlay; and it should be well considered whether the two other channels of outlet, partly executed by nature, and to a great extent already improved by art, may not, when perfected, suffice for all the wants of the region.

Klinger's Gap Coal Strata.—The strata of the N. side of the Basin are well exposed at the notch called Klinger's Gap. The details there collected, taken in connection with those of Donaldson's Colliery on the one hand, and those of Bear Gap on the other, will give a sufficiently correct notion of the general contents of the basin. Towards the middle of the valley higher coals occur than any met with at these localities, which, however, represent all the most important or lower beds, or those which, rising highest above the water-levels of the district, are of easiest access, and which are at the same time the thickest, the soundest, and the most valuable for the quality of their fuel. These lower White-Ash coals form a belt on each side of the valley, where they rise high above the stream, outcropping in the flanks of both the enclosing mountains.

Klinger's Gap.—At this important breach in the N. barrier of the Wiconisco Basin the coals are in ascending order.

No. 1. 60 feet from the red shale is a small 2½-feet coal shafted on.

„ 2. 90 feet further a drift on a 7-feet vein, worked 8 or 10 years ago. The coal was good at first, but squeezed; the gangway was worked in 173 feet; the dip is rather more than at Donaldson.

„ 3. 87 feet to the drift on a 5-feet thick coal, 100 feet in, with only 2 feet of good coal.

„ 4. 192 feet to an old drift on a 6-feet-thick bed of good coal, worked in 150 feet.

„ 5. 130 feet to a small coal, with a drift.

„ 6. 288 feet to a small coal shafted into on the mountain.

„ 7. 372 feet to a coal 11 feet thick; the 10 feet of Donaldson worked in some distance. It is immediately on the top of a coarse Egg-conglomerate; over it lie 12 feet of slate, on the top of which is 4 feet of solid coal, worked at the second drift, but only 5 yards in.

„ 8. The Iron-ore coal, 2 feet, is shafted on the mountain 60 feet N. of the Lomason or Big Vein.

„ 9. The Lomason or Big Coal, 10 feet thick, in two benches, the top 4 feet, bottom 6 feet thick; the ashes of the bottom are white, of the top grey. It was worked in 50 yards; the coal is good.

„ 10. 100 feet to a 4-feet coal—the Black Heath Coal, locally the Peacock; worked in 300 yards; very good; dip 58° S.

„ 11. 20 feet slate to the Black Valley Coal, in drift, it is 24 feet thick. It averages 16 feet of coal, and has 5 feet of impure coal in the bottom; it was worked in for 150 yards.

„ 12. 40 feet to a 4-feet bed of good coal, with a sandstone top; the gangway ran in from 12 to 15 yards; it had fallen in.

„ 13. 40 feet to two small coals, shafted on; 2 feet thick each, and about 6 feet apart.

(See Section of the E. side of the gap, Plate III. of Sections.)

A plate of dark-grey argillaceous iron-ore, very carbonaceous, and full of vegetable fossil forms, lies immediately over coal No. 8 of our Section. It is about 8 inches thick, and is separated from the coal in the roof of which it lies by about 12 inches of black carbonaceous laminated slate. It has been erroneously called the *Black Band Iron-ore.* It is extremely interesting from its partial resemblance to the proper blackband of Scotland, to the admirable qualities of which much of the marvellously rapid progress which that country has recently made in the smelting of iron may be attributed. Should this stratum of the Bear Valley Basin prove to be generally diffused, and of profitable thickness for smelting, its proximity to the anthracite as a fuel would confer upon it the highest economical value. Promising to be superior in quantity and cheapness to many other of the bands of iron ore yet met with in the anthracite region, I have given it a very careful examination, and the following are the results: The layer of ore is strictly a continuous sheet within the roof-slate of the 3-feet coal-bed next N. of the Lomason seam, and in such close proximity to the coal that they might be both mined together, and the expense of getting the ore thereby materially lessened. Its maximum thickness is 12 inches. This it maintains throughout the length of the coal-drift on the E. side of the gap, which is 300 yards long. On the W. side of the notch its thickness appears to be less, probably not more than 7 or 8 inches. The value of the ore for conversion into cast-iron is materially impaired by the presence of a considerable proportion of *sulphur*, certain parts of it being decidedly pyritous.

With a view to ascertain the permanency of this band of ore, I examined the locality of the old opening of the great bed about 1¾ miles E. of the gap, and there discovered it, but was convinced, so far as I could infer from the magnitude of the outcrop, that it undergoes, even in that district, a material reduction in thickness. Tracing the belt containing it to Donaldson's Mines, it was ascertained that it is there altogether absent, or only very faintly indicated; for while the coal and roof-slate, which it should accompany, are well exposed, and have indeed been

opened with a view to its discovery, the ore itself could not be found. We shall presently perceive that it is not more persistent in the opposite or Western direction, and that no trace of it has been detected at the mines near Bear Gap, though its coal-bed is readily identified. What its more precise limits may be in the vicinity of Klinger's Gap, it is impossible, in the present undeveloped condition of the locality, to ascertain without patient and prolonged research. Should it retain its fullest dimensions of 10 or 12 inches, and prove pure enough for smelting, the great cheapness with which it may be mined must, I think, recommend it as a promising basis for iron-works at the gap. But even with a thickness of 12 inches, the limited district within which it possesses this size would soon become exhausted, unless the other argillaceous ores should prove to be likewise abundant and continuous; and of this fact we are at present in entire uncertainty.

Bear Gap.—The natural transverse section of the coal-formation at Bear Gap exposes the strata in the South Mountain, dipping N. at angles varying from 50° to about 30°. It is probable that this inclination, which is a favourable one for cheaply extracting the coal, continues with the strata to near the W. end of the basin, growing gradually less towards the extremity. The average dip of the same rocks in the North Mountain is S. about 40° or 45°, and this steepness also declines as we advance to the W. On the N. margin of the coal-field, towards its W. end, the inclination of the beds is quite gentle, a condition which may be highly profitable, as giving a great breast or slant length to the coal-seams above the water-level of the interior valley.

The coal-formation at Wiconisco appears to contain two groups of productive coal-beds, together with a few thin and profitless seams in the intervening strata. The lower group consists of four coals, the first beds met with on entering Bear Gap from the S. These are enclosed between the conglomerates and sandstones which immediately overlie the red shale formation, the lowest coal of all, having but about 150 feet of those rocks between it and the red shale.

The upper coals occur in the very centre of the basin, in the highest strata of the section, and are intersected in a crushed state in the tunnel. These lie among hard grey argillaceous sandstones and compact silicious slates. They are three or four in number, and are in their least disturbed state on the N. side of the synclinal axis, or turn of the strata, in the middle of the basin. At the tunnel, and for a few hundred feet E. from it, they are squeezed, and in a condition unfit for mining; but further forward, in the same direction, they assume their regular full dimensions, and are yielding on their S. dips very excellent coal.

Both the N. and S. outcrops of the lower group will be found several hundred feet *outside* of the actual summits of their respective mountains, and a considerable distance down from their crests.

This lower series will probably be found to extend to the termination of the coal-basin, beyond where the two mountain-crests unite, and to sweep their lines of outcrop through the E. part or club end of the mountain-spur in which the basin ends, thus forming an outer belt encircling the whole coal-field. Each of these coals spreads, of course, under the entire basin We may estimate their average height of breast above the level of the gap at between 400 and 700 feet, increasing as we approach the extremity of the basin.

Coal 1.—The lowest of the whole group varies in its thickness, which, estimated between its

top and bottom slates, is from 5½ to 7 feet. It will not be fair to count upon more than 5 feet of good coal in it, even where it is unaffected by faults.

Coal 2.—East of the Wiconisco Gap this bed has a thickness of 10 feet, and may be estimated to produce, when sound, about 8 feet of good coal.

Coal 3.—This bed has a maximum thickness of 4 feet.

Coal 4.—Measures about 3 feet, and is, I imagine, nowhere rich enough in pure coal to be profitably wrought.

Between 5 and 6 tons of coal to the square yard of surface may be considered as the maximum yield of this group of beds, where they are unaffected by a squeezed condition of the strata; but so prevalent are faults or steps along their lines of outcrop E. of Wiconisco Gap, that I think it will be prudent to make an abatement for soft and unmerchantable coal, and to estimate the actually available quantity as not more than 4 tons to the square yard, or about 20,000 tons per acre.

Some, if not all, of these lower seams have by this time been reached by the tunnel and the North Mountain.

The upper series of coals is of much more restricted limits than the lower, just described. They have their N. outcrops at Bear Gap, over the N. half of the tunnel, or immediately N. of the central line of axis of the basin. Their S. outcrops, from being near the bed of the stream, which, in approaching the gap, encroaches more and more S. of the middle of the basin, are deeply covered with debris, and have not been yet detected. In the tunnel, as already said, all of these coals are squeezed out by faults, but Eastward they have been wrought, and are of the following dimensions :—

The *Hoffman* Coal, the lowest of this group, is intersected near the N. end of the tunnel, and is E. of this locality about 4 feet thick. Its outcrop is rather high on the inner slope of the North Mountain.

The *Air-Hole* Coal, the next overlying bed of profitable size, is pinched to a thickness of 2 feet in the tunnel, but a few hundred feet Eastward it measures 6 or 7 feet.

The *Etting* Coal shows an average thickness of about 8½ feet, where it has been mined 500 or 600 feet E. of the tunnel.

The *Pat Martin* Coal, the highest of the series at the tunnel, has, when regular, an average thickness of from 5 to 7 feet.

Where these coal are sound, they are all of a valuable size, but from their position so near a much-compressed synclinal axis, or turn of the dip in the basin, I fear that, at least, in the vicinity of Bear Gap, they will be found in a more damaged or soft state. The space which they occupy in the basin will be found to contract going Westward, and they will not be seen to extend to the head of the valley.

The Hoffman Coal ranges furthest Westward and occupies the largest area between its N. and S. outcrop, and it may reach nearly to the point where the two mountains coalesce. Each of the others, taken in the ascending order, will have a more and more restricted area, and the two uppermost, the *Etting* and *Pat Martin* Coals, cannot, I think, be prolonged very far Westward of the tunnel.

What amount of merchantable coal this upper group may contribute it is not possible to say, until a greater extent of superficial mining enables us to trace the actual outcrops of the seams.

So also it would be idle to attempt at present an estimate of what is by far the most important practical consideration relating to such a coal-field ; the amounts of coal immediately accessible at different points above the water-levels of the basin, and the quantities procurable by tunnels, shafts, or other artificial inlets. These results depend on data only procurable by close instrumental surveys, more appropriately conducted by the proprietors of estates than by the Geological Survey.

Looking at our Section of the Wiconisco Basin at Bear Gap, the conversion of the Seral conglomerate of the E. half of the Pottsville Basin into productive Coal-measures of the ordinary type, is even more conspicuous than in the Sharp Mountain west of Tremont. In the entire thickness of the Southern or Lick Mountain, the amount of coarse pebbly rock does not constitute more than one-tenth of the entire body of the strata, the chief mass of which consists of argillaceous sandstones and soft shales. The lowest bed of all, or that in immediate contact with the Umbral red shale, has a thickness of about 40 feet, while the other pebbly beds are between 20 and 30 feet thick. A hard stratum of sandstone about 50 feet in depth forms the main crest of the South Mountain, whilst the lowest conglomerate produces a bench or high terrace upon its S. flank. Between this conglomerate outcrop and the main crest all the four coals of the lower group rise to the surface upon the outer terrace, while the other four outcrop at a lower angle averaging 30° N. upon the long gentle N. slope of the mountain between its crest and base in the valley of Bear Creek.

Opposite Bear Gap there is a narrow, sharp, compressed anticlinal flexure N. of the middle of the valley, which extends, in all probability, from near the W. extremity of the coal-field a long distance Eastward. It produces of course two synclinal turns of the rock, where otherwise there would be but one, and is the main cause of the pinched and crushed condition of nearly all the coal-seams of the centre of the basin. Whether it is merely superficial, or extends throughout the thickness of the formation, it would be idle to conjecture, until a greater extent of deep mining makes us better acquainted with the nature of these sharp surface-undulations. This narrow anticlinal turn or sharp saddle, and the two synclinal axes embracing it, are all intersected in the Bear Gap Tunnel, which, passing beyond them, penetrates the South-dipping coals of the North Mountain, where there is reason to presume the coal will be in a much more merchantable condition than in either the Bear Mountain or the centre of the valley.

THE DAUPHIN BASIN.

In describing the Southern of the Western divisions of the First Anthracite Basin, I shall avail myself in part of the data collected and published by the late Richard C. Taylor, Esq., of Philadelphia, an eminent and very skilful practical geologist and mining engineer, by whom this district was originally investigated. While employing his details, I must observe that my own later observations have shown me that the thicknesses assigned to some of the coal-beds are too great. A preliminary generalised view of the whole district will aid the geological student, by a clear conception of its structure, to a sound notion of the conditions under which the coals exist.*

This long and narrow trough of Coal-measures is an elevated mountain-valley of simple synclinal form, having for its Southern barrier the crest of the Sharp Mountain, and for its Northern that of

* If opportunity permits, I shall introduce into the Appendix some recently gathered and more correct results respecting the Dauphin Basin and its coal-seams.

Fourth Mountain. From the gap of Lorberry Creek to its W. termination in the synclinal knob which points towards Dauphin, its length is about 28 miles. Between Lorberry Creek and the West Rausch Gap, a distance of 11 miles, this basin, between one outcrop of the conglomerate to the opposite, diminishes in width from about 6000 to 4000 feet, and Westward from the latter locality it continues to contract until the whole becomes a mere narrow belt in a single synclinal ridge, which terminates within 2 miles of the Susquehanna River. Advancing Westward, the general bed of the valley progressively rises, until, where it is within 10 or 12 miles of the river, it attains a height of 1200 or 1400 feet, and it retains this elevation to its termination. It is not so much a valley in its form as a high narrow plateau, belted on each side by a narrow crest only slightly elevated above the general plain. The close proximity of the two massive barriers of conglomerate have preserved its softer coal-rocks from any steep general excavation by diluvial waters. Near every notch in its S. barrier, the bed of the valley, both to the E. and W., is trenched by the waters to a much greater depth than elsewhere. By these gaps, which are confined to the Sharp Mountain, the coal may find a ready outlet into the longitudinal external valley of Stony Creek, a railroad having been constructed, with branches and planes penetrating each gap, to convey it to the Susquehanna River. The basin holds throughout its length the features already represented as belonging to it at the Lorberry. The strata composing its S. half are all in a perpendicular, or even an inverted position, while those of the N. side dip S. at a high angle. As far nearly as the Yellow Spring Gap this vertical dip of the Sharp Mountain strata continues, and indeed the beds are in some localities so much inverted as to dip S. 70° or 80°. In the same distance the S. dips of the other side diminish from about 70° to 50°. Beyond the Yellow Spring Gap the inclinations of both sets of strata grow progressively less, until at the Big Flats, 6 miles from the termination of the mountain, the dip is but 30° to the N., and only 20° to the S.

All along the Sharp Mountain, even to the termination of the basin, the strata—more especially the coal-beds of the S. side—are to a considerable extent faulty or disturbed; but this is probably the result rather of the excessive internal sliding pressure produced upon them by the close folding of the thick and ponderous mass, than by a wrenching force connected with any great dislocation. It is worthy of note that throughout the entire length of this basin the strata along the central belt are in a broken or crushed condition, and any attempt to reach solid coal there has been unsuccessful. The close synclinal doubling together of the rocks has greatly bruised all the materials along the axis of the trough.

I shall now proceed to describe the coal-beds of this basin. These will be best illustrated by a series of Sections constructed from the details contained in the work of Mr R. C. Taylor, where the reader will find the originals, of which these are not strictly copies, but modifications intended to embody, with his measurements, my own conceptions of the structure of the basin.

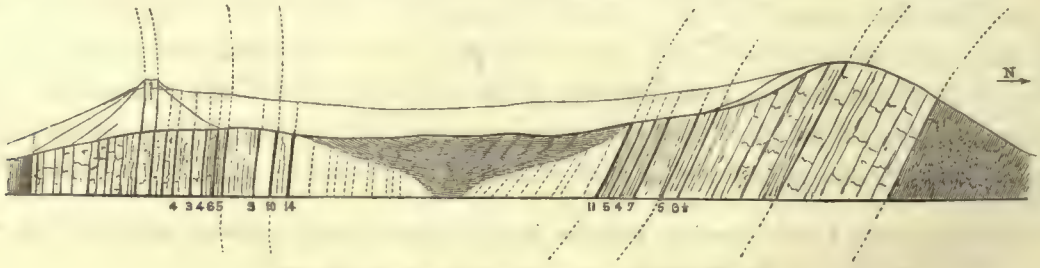


FIG. 181.—Section at Black Spring Gap, Dauphin Basin.

At *Black Spring Gap*, which is 26 miles from the Susquehanna, and 4½ miles from the Union Canal Reservoir, mining explorations have brought to light eight beds of coal in the S. belt, and six in the N. The dimensions, distances apart, and dips of these, are given in the accompanying Section.

The *Four-Feet Vein*, the most Southern one opened, is 170 feet N. of the vertical wall of conglomerate which here forms the crest of Sharp Mountain. It has a breast of 300 feet, has been occasionally mined, and is a pure free-burning anthracite.

The *Peacock Vein* is from 6 to 8½ feet thick at a shaft midway between Black Spring Gap and Mount Eagle, but is thinner at Mount Eagle. This coal contains 7 per cent of volatile matter.

The *Heister Vein*, 10½ feet thick, and with a breast 250 feet high, had, when seen, a drift in it 1000 feet long. One layer of this coal is excellent.

The Grey Vein.—This bed has been reported to contain about 14 feet of pure coal, and to have a total thickness of 16½ feet, but my own observations do not confirm this statement.

Iron Ore occurs in this group of strata, in the shales S. of the Peacock Coal, in three layers of balls.

At the Black Spring Gap the conglomerates of the Sharp Mountain and the included coals dip a little S. of the perpendicular.

In the centre of the basin there is a belt 2100 feet wide between the two sets of coal-beds, where no coal has been discovered; but wherever a shaft has been dug, there has been found a great depth of fragmentary matter, or superficial "wash."

On the N. side of the basin the several coals of the series opened are, according to Mr Taylor,—

The *Tunnel Vein*, 3½ feet thick.

The *Five-Feet Vein*, a good coal-bed 5 feet thick.

The *Lea Vein*, 7 feet of good coal, with an undermining.

The *Slaty Vein*, 4 feet.

The *Carey Vein*, 5 feet of soft and flaky coal; and the

Fishback Vein, 8 to 11 feet. This coal contains 9½ per cent of ashes, and 6½ per cent of volatile matter.

The coal-beds of this N. group dip S. at an angle of 70°.

My own personal inspection of this ground convinces me that the above-stated thicknesses are exaggerated.

At the Gold Mine Gap, 1½ miles W., the Peacock, Heister, and Grey Veins, and one or two more, have been proved and opened; but the next details I shall here present are those of

The Rausch Gap Section.—Five miles W. of Black Spring Gap is Rausch Gap, where the coal-beds have the positions and dimensions shown in the following Section (fig. 182).

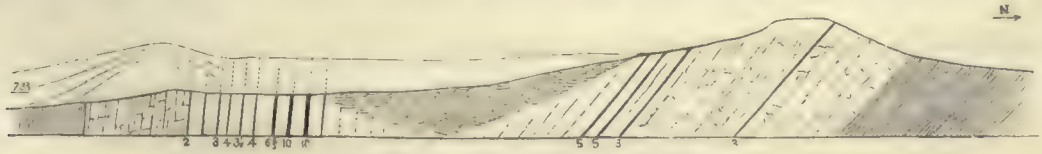


Fig. 182.—Section at Rausch Gap, Dauphin Basin.

There have been developed in the Southern belt at this locality ten independent seams, two of which are of important dimensions.

The *Heister Vein*, said to be 10 feet thick, contains 6 feet of good coal.

The *Grey Vein* measures 9½ feet of coal; it has been driven into.

It is an interesting feature of the coals of this locality, that they are decidedly *bituminous*, displaying here the first distinct manifestation of a transition from semi-anthracites into the more adhesive or *dry coals* of the semi-bituminous class. We shall presently perceive that the proportion of bitumen gradually increases from this point Westward to the termination of the basin. Here the composition of the most Southern coal-bed of the Section, the Pitch Vein, is as follows:—

Carbon,	78.90 per cent.
Volatile Matter,	11.00 „
Ashes,	10.10 „

The analysis of the Heister Coal shows these proportions:—

Carbon,	73.10 per cent.
Volatile Matter,	10.90 „
Ashes,	12.00 „

The coal of the *Peacock Vein* burns with a yellow flame for a short time, denoting in it also the presence of bitumen.

Four beds have been opened on the N. side of the basin at this locality: one of them, on the summit of the mountain, is conceived to contain the best coal of the group; they were not wrought far enough to fully develop them.

Yellow Spring Gap Section.—About 5 miles W. of Rausch Gap is that of Yellow Spring, where, in a series of exploratory shafts, Mr Taylor brought to light the facts exhibited in the following Section (fig. 183).

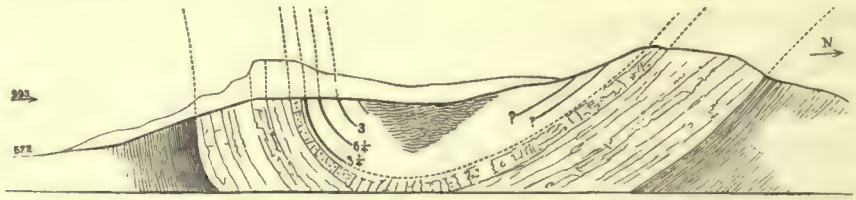


Fig. 183.—Section at Yellow Spring Gap, Dauphin Basin.

At this locality, 16 miles from the Susquehanna, the principal coal-beds outcrop at an elevation above the Pennsylvania Canal of 990 feet. There are here five separate beds discovered on the S. side of the basin, two of them only partially proved, the other three regularly opened within a transverse distance of 150 feet. One of these, lying immediately N. of the main bed of conglomerate, forming the *backbone* of the ridge, is called

The Backbone Vein.—It is 3½ feet thick, and yields 3 feet of good hard coal. This bed dips 85° N.

By analysis the coal contains, according to Lea,—

Carbon,	74.70 per cent.
Volatile Matter,	14.80 „
Ashes,	10.50 „

Our own analysis shows only about 10 per cent of volatile matter.

The *Kugler Vein* is about 6 feet thick, and dips 68° N. A drift has been cut in this bed

276 feet in length, and the coal was everywhere good. It burns with a pure flame, and contains,—

Carbon,	77.50 per cent.
Volatile Matter,	11.00 „
Ashes,	11.50 „

Another coal-bed is 3 feet thick. This dips only 37° N., and thereby possibly indicates that here the strata are bending to form a flat and shallow bottom to the basin.

About 60 feet N. of the last is another small coal, the size of which is unknown.

A fifth coal-bed outcrops to the *South* of the backbone of the mountain, but the thickness of this had not been proved.

On the N. side of the basin two or three coals are seen, but they have not been proved.

Neither of the large beds developed at Rausch Gap have been yet discovered at this locality, and it is questionable if they extend thus far towards the W.

Rattling Run Gap.—At this ravine, which is the deepest in the basin, and the nearest to the Susquehanna, the explorations by Mr Taylor brought to light a number of coal-beds, of which two or three are thick enough to be profitably wrought. Here have been disclosed sixteen (?) outcrops in the Sharp Mountain, twelve of which are on the *South* side of the belt of rock which generally forms the crest, and four are near the summit. Two other coals of valuable dimensions are on the N. slope. The N. side of the *basin* has developed two or three beds. The sixteen Sharp Mountain coals are all thin, varying from 1 foot to 3 feet in size, and, like the coal in the conglomerate generally, are not sound enough to prove profitable, and some of them do not merit the name of proper coal-seams. They have a dip at the surface of 70° N.

The following details will explain the composition of the basin at Rattling Run :—

1. The distance from the red shale to the lowest or the 2½-feet coal of Sharp Mountain is less than 170 feet, chiefly soft shale.
2. The next belt of strata, chiefly conglomerate, is 100 feet wide.
3. Slate and argillaceous sandstones 140 feet, embracing four thin beds of coal.
4. Argillaceous rocks, including two thin coals, 130 feet.
5. Hard conglomerate, 100 feet wide,—contains one small coal.
6. Argillaceous strata, 160 feet wide at the surface, with three coals.
7. Conglomerates and sandstones, with thin layers of slate, 300 feet.
8. Grits and argillaceous strata, chiefly the latter, 240 feet,—three coals.
9. Conglomerates and sandstone, with a few soft strata, 450 feet,—one coal.
10. Alternating grits and shales, 1000 feet. In this space is embraced the two best coal-beds of the tract. It also embraces the obscure and broken ground in the middle of the basin.
11. The strata of the Fourth Mountain, from the coal to the red shale on its N. slope, are about 2800 wide, with a dip of 46° S.

The entire breadth of the belt from red shale to red shale is 5590 feet.

A feature which deserves attention in this Section is the occurrence of so many thin coal-beds, and of so much soft argillaceous rock throughout the conglomerate, or, more strictly, the merging together of the lower Coal-measures and the Seral conglomerate, the division between which, adopted purely for convenience sake, we have seen all along to be arbitrary. The position which the crest of Sharp Mountain occupies in the formation depends manifestly on the place occupied by the hardest and most massive stratum of conglomerate, since this would most

resist the wearing action of floods; therefore at this locality, where the inferior rocks are the softest, and include beds of coal, these have their outcrop to the South of the summit.

Of the coal-beds here discovered the most important is that called the *Perseverance Vein.* This had been mined in a drift 400 feet long, and consisted of two layers containing together 4½ feet of coal, showing symptoms of enlarging.

On the Fourth Mountain a bed was discovered measuring 3½ feet thick.

Big Flats.—The following Section (fig. 184) will explain the structure of the basin at the Big Flats, a table-land, 2 miles in length, about 6 miles from the end of the mountain, and 4½ W. of Rattling Run. At this portion of its course the middle of the basin has risen until it forms the summit of the one synclinal ridge caused by the approach of the two monoclinal barriers of the basin, and the denudation of the external softer strata.

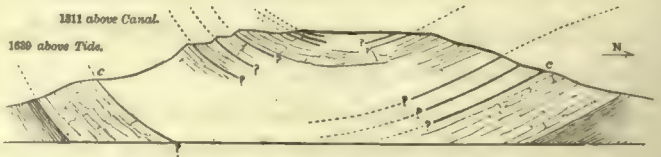


FIG. 184.—Section at Big Flats, Dauphin Basin.

Between the two outcrops of the red shale the width of the formation here is 2500 feet. The elevation of the plateau above the canal is 1327 feet. Near the very summit two or three beds of coal have been proved, and one of them ascertained by mining to be 2½ feet thick. These dip 18° N.

The following is an analysis of this coal by Professor J. C. Boott :—

Carbon,	71.20 per cent.
Volatile Matter,	15.32 „
Ashes,	13.46 „

Traced still farther Westward, we find the belt of coal strata to grow narrower and more shallow to the end of the mountain, the last 4 or 5 miles not having a breadth of more than 1000 feet. This tract includes of course only the very lowest portion of the series, or rather only the Seral conglomerate, with the few thin coal-beds embraced in its inferior beds. All the higher strata have been washed away.

CHAPTER XII.

MINE HILL BASIN, AND MINE HILL.

IN order not to interrupt the continuity of description of the closely-united anticlinal and synclinal belts of the main Southern Coal-field, I have postponed the account of the Mine Hill Basin and Mine Hill to this place, though a more purely geographical arrangement would have introduced them in an earlier Chapter: indeed, they might have been discussed as prolongations of the Basin *C* of the foot of Locust Mountain, and of the anticlinal flexure C of the vicinity of Tuscarora; but this would have been to dissociate their Western tracts too much from the corresponding parts of the main basin.

It will assist us to a clearer apprehension of the somewhat irregular form of the Mine Hill Basin, if we first examine the structure of the anticlinal ridge S. of it, called the Mine Hill.

STRUCTURE OF MINE HILL.

In a former chapter the Southern anticlinal axis of the Eastern end of the coal-field, or that of the S. edge of the town of Tamaqua, was assumed as coincident with the main flexure of the Eastern point of Mine Hill. This view of their identity, though *proximately*, is not *strictly* correct ; indeed, there is every reason to believe that the Sharp Mountain axis C is itself not strictly continuous as far W. as the village of Tuscarora ; and there are still stronger grounds for regarding the South Tamaqua axis, traceable apparently to Tucker's Slope, as ranging considerably N. of the axis of Mine Hill, assuming this to be the flexure which passes just S. of the mouth of the Palmer Tunnel. The Mine Hill flexure, or group of flexures, is not only somewhat out of line with the Tamaqua one, but it is out of direction with it, bearing considerably more N. as it ranges W.

Mine Hill may be best described in two divisions, an Eastern and a Western, separated by Mill Creek. The Eastern, extending from Big Creek to Mill Creek, is a broad and nearly straight ridge, with a somewhat flat summit—a Southern wing, as it were, of the plateau of Broad Mountain. The Western Section, embraced between Mill Creek and West-West Branch, is a straight and narrow ridge, with a somewhat sharp crest and comparatively steep flanks. Eastern Mine Hill is partially divided from Broad Mountain by Big Creek on the East, and by Upper Wolf Creek on the West ; but the watershed between these streams is very high, the indentation hardly there insulating Mine Hill from Broad Mountain. Silver Creek crosses this high valley Southward, and an extensive reservoir of its waters has been constructed at its passage across the high valley by the erection of an extensive dam of rude masonry ; this reservoir is for the supply of water to the Schuylkill navigation during the droughts of summer. The elevated shallow valley occupied by Big Creek, by Upper Big Creek, the Silver Creek Pond, and Upper Wolf Creek, is an almost continuous shallow coal-basin, for coal has been opened not only on both sides of Big Creek, high towards its source, but also at the Silver Creek reservoir, and again at sundry points W. of the Broad Mountain Road, in the valley of Upper Wolf Creek.

Eastern Mine Hill, thus insulated from the Broad Mountain, seems to embrace in its central portion, or that intersected by Silver Creek, as many as three anticlinal flexures : the most Northern of these is the axis which, just S. of the mouth of Upper Wolf Creek, separates the Coal-measures of that basin from those of the colliery at the head of Mine Hill Valley, long known as Lawton's ; it is confined to the N. brow of Mine Hill, overlooking Wolf Creek. It is an acute flexure at Mill Creek ; but whether it extends as far E. as Silver Creek, is still, we believe, uncertain.

The central or main axis of the ridge is that which is visible on both sides of Mill Creek, in a noble arch of the conglomerate and lower White-Ash Coal-measures. The span of this arch or wave, measured from the synclinal turn of Lawton's Big Coal to the first N. dip in the same coal at the foot of Johns' Slope, is about 3400 feet ; it is a fine example of a flexure of the regular normal type, the S. dips increasing as we approach the axis from 30° to 40°, and then abating, until the strata flatten at the crest of the wave, where the N. dips commence to augment rapidly in steepness, becoming soon as high as 60°, and even 70 , as we approach the N. foot of the wave. At this intersection of the flexure, three beds of coal are met with on both sides of

the anticlinal axis; between the conglomerate and the Lower Big Seam, one of them is steadily wrought on the S. slope, and two of them have been opened for mining on the N. dip, but were, from the abruptness of the flexure, found too faulty to be pursued.

The basin, or the synclinal flexure between this central axis and the Northern one adjoining Upper Wolf Creek, rises so rapidly to the Eastward of Mill Creek that these three lower coal-seams are not likely to range far along the Mountain in that direction. The Big Coal of the Mine Hill Basin (Lawton's), conforming to this rise of the synclinal axis, does not enter the face of Mine Hill, but terminates with a spoon-shaped outcrop just W. of Mill Creek. It is difficult to say whether this central axis of Mine Hill is or is not the same with that which passes Eastward through the point of the ridge at Big Creek, and courses thence across Swift's Creek, and past the mouth of Palmer's Tunnel to Tuscarora. As forming the main crest of the ridge, they may be viewed as its central axis throughout, even though not strictly continuous. It is quite probable that, like the axis C, nearly in line with it farther E., it is made up of shorter flexures ranged in echelon. As the main conglomerate mass underlying the productive Coal-measures outcrops upon the line of this axis, high on the Eastern slope or point of Mine Hill, it is obvious that the workable beds of Big Creek do not ascend the Mountain very far, but fork into two lines of outcrop, the South-dipping one taking a course already traced, along the S. slope of the ridge to Silver Creek, the steeper North-dipping one a parallel course in the N. slope of the ridge towards the Silver Creek dam.

The third or most Southern anticlinal flexure of this division of Mine Hill is the axis D of its S. crest, or the partially-detached spur which I have entitled South Mine Hill. This flexure has been already traced from the Lower Whitfield Tunnel on De Long Creek, past the White-Ash Slope Mine of Casca William, and through Guiterman's Seam of Silver Creek to the S. arch of Mine Hill at Pinkerton's Colliery on Mill Creek. E. of Silver Creek, the anticlinal ridge marking this axis is insulated from the main body of Mine Hill by a high narrow valley containing the lower White-Ash Coal-measures, including the Big Seam; and W. of Silver Creek, the same anticlinal flexure forms a wider and longer spur, which is separated in a somewhat similar manner from the main summit of Mine Hill by the synclinal valley of Lower Wolf Creek, or the trough which embraces the N. outcrop of Johns' Big Seam of Mill Creek. The synclinal structure of this last-named valley is plainly manifested in the features of the district, and has been fully demonstrated by our observations on the dip of the strata, including the openings in the coal-beds. I am not sure that the E. point of the basin of Johns' Great Coal-bed within this valley has yet been ascertained, but it is probably between 2 and 3 miles E. of Mill Creek.

WESTERN MINE HILL.

In point of structure and topography, the other division of Mine Hill, or that lying W. of Mill Creek, is much simpler than the Eastern, just described: it would seem to contain but one principal flexure of the strata, and this a wave of the true normal type, moderately gentle in the inclination of its S. flank, and steep in that of its N. We have seen that at Mill Creek the steepest S. dip of the wave was about 40°, and the steepest N. dip 75°, and very nearly similar are the slopes of the curve at the passage of the West Branch, where the ridge, intersected to its base, exposes another grand arch of the conglomerate and lower Coal-measures. From Mill Creek

to the West Branch, or the Mine Hill Gap, as it is called, and all the way, indeed, to West-West Branch, this undulation appears to decline steadily in width and steepness: thus at Mill Creek the Seral conglomerate rises almost to the summit of the ridge, and the breadth of its arch between the two outcrops of the lowest coal is not less than 2100 feet; whereas at the passage of the West Branch, though the hill is lower, the conglomerate is arched by the lowest Coal-measures under the summit, and measures from abutment to abutment not more than 1650 feet. Approaching the West-West Branch, the flexure grows very flat, and opposite the mouth of Buck Run it is probable that even its N. dips hardly exceed 20°. Whether this flexure contains but a single anticlinal axis, or is a little complex at its crest, is not quite certain. I am inclined to believe that it embraces two axes, or is, in fact, a double flexure at its summit a little W. of the Centre Turnpike. The breadth of this part of the ridge, and the bold shoulder which it throws forward towards Mine Hill Valley west of Newcastle, imply that two anticlinal axes may here lap past each other, and produce between them a narrow and shallow synclinal trough, which may even contain one or two of the lower coal-beds of the Mine Hill Valley, lifted obliquely into the mountain, as a species of short Southern spur from that basin.

It is obvious, from the foregoing description of Mine Hill, that no productive Coal-measures, except in the several localities we have alluded to, are likely to be found along the top, or even high on the slopes of this ridge, either in its Eastern or Western sections.

MINE HILL BASIN, ITS STRUCTURE, COAL-SEAMS, AND COLLIERIES.

The Mine Hill Basin, taking the name in its largest sense, is the complex trough of Coal-measures included between the main anticlinal crest of Mine Hill, and the S. brow or slope of the Broad Mountain. All the central part of the belt, or that embraced between Newcastle and Heckscherville, is a nearly simple synclinal trough of a normal curvature of the strata—that is to say, the North-dipping Coal-measures S. of its main synclinal axis, in the flank and at the foot of Mine Hill, dip steeply to the N., while those to the N. of that line, at the foot and in the slope of Broad Mountain, dip S. at a more moderate angle. Towards both of its extremities, however, this basin forks or subdivides into two branches. Of these bifurcations the Western is the most symmetrical. The subdividing of the Eastern end of the belt is occasioned by the presence there of a narrow steep anticlinal wave, which, prolonged Westward from the N. brow of East Mine Hill, crosses Mill Creek just S. of the mouth of Upper Wolf Creek, and ranges along the S. slope of Broad Mountain, almost directly in a line, to meet the anticlinal axis of the Peaked Mountain. This axis is traceable continuously from Mill Creek to the ravine of Butcher Creek; how much further it extends is uncertain. It appears to originate near the foot of Broad Mountain east of Coal Castle, and to make a sharp flexure in the lower White-Ash Coal-measures, rising gradually as it advances Eastward, until, at Kelly's Hollow and the mouth of Wolf Creek, it insulates a narrow sharp basin or V of the big lower coal-seam between itself and the main S. slope or brow of Broad Mountain. This narrow and pinched basin prolongs itself into the synclinal trough of Upper Wolf Creek, and thence through the Silver Creek reservoir to the head of Big Creek. Whether any of the Big Coal remains E. of Mill Creek, or in the part of the trough occupied by Wolf Creek, appeared, at the time of our observations, to be extremely doubtful. As a slender synclinal fold this narrow strip of the Coal-measures may be viewed either as a Northern

branch of the Mine Hill Basin prolonged beyond the main Southern division, or as a Westward extension of the basin of Upper Big Creek, contracted and pinched towards its Western termination. Our Section of strata on Mill Creek exhibits clearly the relations of this narrow compressed synclinal belt at that ravine, to the broader basin S. of it. The pictorial sketch of Montelius's Open Mine in the Big Coal bed at the synclinal axis, illustrates the sharpness with which the Coal-measures, conglomerates and all, are here folded.

It has been already intimated that the main Mine Hill Basin ends in the table-land of Mine Hill, at no great distance E. of Mill Creek, the Upper or Big Coal not extending beyond the stream.

The W. forking of the basin is caused by the rising of an anticlinal axis, which originates somewhere E. of Heckscherville, or is possibly a prolongation of that S. of Upper Wolf Creek, rising Westward, and becoming the anticlinal of Peaked Mountain. This axis produces, with Mine Hill and Broad Mountain, two branch basins—shallow, symmetrical, synclinal valleys—which rise Westward into the table-land at the head-waters of the main Swatara.

The more Northern of these sub-basins, watered towards its W. end by the head-stream of the West-West Branch, is considerably the longest. The other or S. one, drained by the rivulet called Buck Run, reaches across the West Branch into the S. slope of Buck Ridge.

All along the N. side of the Mine Hill Basin, the outcrops of the several thick coal-seams of the lower White-Ash group, with their adjoining soft shales, are plainly indicated on the slope of Broad Mountain in a succession of soft indentations or vague terraces, which wind in and out at nearly constant levels, dimly seen in the ravines, but prominent enough on the buttresses or the spurs between them.

Having thus defined the general structure of the belt, I shall now proceed to offer some details concerning the more important collieries and coal-beds.

COLLIERIES AND COALS OF MINE HILL VALLEY.

Lawton's Old Colliery Gap.—This mine is seated in the E. end of the basin.

The coal of the Jugular or lower thick seam of the valley is wrought from a slope descending Westward.

On the S. dip the air-holes ranged W. for 900 yards.

At the date of our last visit the Slope was down 185 yards. On the N. dip the gangway continues all the way into Newcastle at the turnpike road. The dip on the N. gangway is about 60° S., and on the opposite or Mine Hill side of the basin it is 45° N. Under Newcastle, at the lower lifts, the two gangways are about 200 yards apart.

The average thickness of the coal is about 18 feet on the S. side, and from 15 to 16 feet on the N. Above this large bed is the so-called Seven-feet Coal, separated from the main mass by about 4 feet of slate.

The benches or layers in the Big Coal are—1. A bottom bench 6 feet thick, then 15 inches of bony coal and slate; 2. A 15-inch bench with smooth parting slate, and 6 inches of bony coal; 3. A 2-feet bench, with smooth parting layer of slate; 4. A 4-feet bench, with smooth parting of slate; 5. A 3-feet bench, with about 8 inches of bony coal. Then 4 feet of black roof-slate to the Seven-feet Coal.

The miners were driving a tunnel Southward from the S. gangway, to cut an overlying seam, which is 11 feet thick. The tunnel was only begun, and is in the Seven-feet Coal. They expected

to pass in the tunnel 6 yards of actual thickness of slates, and above this a conglomerate. The coal here looked for is that which was mined further W. in the valley, but there is no positive proof of the presence of this 11-feet seam. This thick coal of Lawton's Old Colliery is manifestly identical with that of Fogarty and Kelly's Mine between Mill Creek and Newcastle, and that of Montelius's old open cut.

A tunnel about 200 yards W. of the bottom of the Slope has fully established this point, though the correspondence of the rocks on both sides of the anticlinal axis should have established it long ago. The dip of the measures at the Slope, and of the Slope itself, is 23° N. 20° W.

On measuring by strides from the outcrop of the Pea and Nut-conglomerate below the colliery to the line of the S. outcrop of the Big Coal, we found the distance to be about 250 feet. This corresponds pretty nearly with the distance measured in Adams's Tunnel. This ledge of conglomerate marks at Adams's the second bench, or, on a flatter dip, the third bench above the Egg-conglomerate.

BIG COAL OF KELLY'S HOLLOW.

After many explorations and a long period of uncertainty, the structure and contents of the narrow lateral basin of the slope of Broad Mountain, in the prolongation in the trough of Upper Wolf Creek, may be regarded as settled. It is, as I have already described it, a closely-compressed slender synclinal trough of the lower Big White-Ash seam, or so-called Jugular Vein, of the Mine Hill Valley. For a long time it was believed that the coal opened to the day opposite the mouth of Wolf Creek was the Mammoth bed, and that another large coal lay underneath this or the synclinal axis, and that it corresponded to the large coal of Johns' colliery. The succession of the strata, as may be seen in our Section, early convinced me of the improbability of this statement; and actual explorations by mining have subsequently confirmed the accuracy of the inference, by showing the supposed subjacent coal to be merely the slender point of the V prolonged downward in the plane of the synclinal axis.

At Kelly's Hollow the same thick coal had, at the period of our examinations, been somewhat extensively wrought by Fogarty and Kelly, and is now being mined by other parties. The openings and drifts occur on both sides of both Kelly's Hollow and the ravine W. of Newcastle, the E. side of which is climbed by the Centre turnpike; indeed, the upper levels have been wrought through to some distance beyond this ravine, the furthest air-shaft being now nearly 1000 yards W. of it. The workings are chiefly on the South-dipping coal of the narrow basin, where enormous cavities in the surface along the bench of Broad Mountain, which marks the outcrop, display the thickness of the coal, and the extent to which its roof has fallen in. The dip of this N. side of the basin is S. 30°; the coal has been mined by following the face of the bottom slate: near Kelly's Hollow the breast or slant height was 110 yards, and the thickness of the seam 30 feet. It consists of two main benches, a bottom one 8 feet thick, and a top bench 21½ feet thick, separated by a layer of slate varying in breadth from 4 to 10 inches. Overlying the thick bench is a bed of slate 2 or 3 feet thick, and above this a 3-feet-thick bed of coal, which burns to a pink ash.

At Kelly's Breaker we may see the outcrop of the Big Coal of Lawton's colliery, the S. face of the hill showing its bottom rock, and the sandstone and conglomerate beneath it; and the railroad ascending Kelly's Hollow cuts two coals in these lower measures, a 3-feet seam 60 feet below the Big Coal, and a 4-feet seam 120 feet below the same conspicuous landmark, all dipping gently S. from 10° to 20°.

MINE HILL VALLEY, FROM MINE HILL GAP WESTWARD.

Pine Knot Colliery (Adams and Miller).—At this colliery, near Coal Castle, there is a slope on the *Daniel* Coal. The distance down was 120 yards: the dip at the slope is 40° S.; Eastward it increases to 60°. The seam has a total thickness of 18 or 22 feet. At a fault to the E. of the workings it is only 4 feet thick. It has five benches—*a.* bottom bench, from 3 to 5 feet of clear pure coal; hard slate from 3 to 4 inches thick; *b.* 18 inches of good coal-parting; *c.* a 2-feet bench-parting; *d.* a 4-feet bench of bone and slate; *e.* an 18-inch bench-parting; *f.* from 18 inches to 2 feet of slaty roof.

Air-shafts extend Eastward about 1000 yards; they met a small fault at that distance. The outcrop of coal keeps the foot of Broad Mountain all the way. There is an opening on the seam a little W. of Newcastle, about 500 yards E. of Adams's last air-shaft.

Above this slope-coal occurs a seam, varying in thickness from 5 to 8 feet. The parting-slate at the Newcastle Mine (Lawton's) is regularly 4 feet thick. The top benches make a kind of pinkish ash.

On the second bench of the Broad Mountain, N. of that which bears the outcrop of Adams's Coal (the Daniel Vein), is a thick coal. This was struck in a tunnel driven from the tip of the slope Northwards about 100 yards, but not precisely at right angles to the strike. The dip in the tunnel is 40°. When struck, it was only about 5 feet thick, in a dirt-fault, but worked E. and W.; it was found to swell out into a coal from 20 to 25 feet thick. A large amount of coal was taken from it. The holes caused by the fall show a thick coal. An Egg and Pea-conglomerate evidently underlies the seam, as shown in the fallen outcrop. The dip of this Big Coal would be about 60°. It has been wrought about 800 yards E. from the tunnel.

Before reaching the Jugular, the miners cut a small 4-feet coal about half-way. It was thought that the tunnel does not reach the Jugular, but the *Tumbling* Coal. The tunnel cuts only one coal besides this, whereas there should be two between the Daniel and the Jugular. Upon this view, the outcrop visited behind Adams's is the *Tumbling* Coal. The interval between the Tumbling and Jugular at M'Ginnis's Mines is not more than 140 or 150 feet.

It is said that the Jugular bed can be traced from M'Ginnis's, by its bottom rock, to the air-holes at the Pine Knot Mine. This would seem to prove their identity.

I have been informed by those who drove and worked Adams's Tunnel, that Adams's Slope Coal is the true Daniel, and that the vein cut at the end of the tunnel is the Jugular. It has there the flaggy sandstone top, which may be readily recognised, and the bench and bottom rock can be followed from M'Ginnis's. The same measures are cut in Payne's Tunnel, but there are five coals between the Daniel and Jugular.

A coal-bed has been opened next N. of the Dutchmen's seam on Mill Creek, and in the bench next S. of the Egg-conglomerate. It contained 6 feet of hard bony coal. This would correspond to the coal opened on the Girard Road, on the N. dip, where it was 5 feet thick. The second bench W. of this is the place where, I think, the Johns' Coal lies, if it exist here. There is no seam known at this point, but a good mass of black dirt and slate. Below, or S. of it, is a dark-grey sandstone, much marked with vegetable impressions, passing at its base into a ledge of Nut-conglomerate. Above is a dark-grey sandstone, intermixed with Pea-conglomerate, like the rock of the small arch at Johns'. Between this last rock and the Southern outcrop of the Lawton Coal is a coal-seam 4 feet thick. It will be seen that in all these particulars there is a correspondence between the three seams in Adams's Tunnel—viz., Lawton's, the Small Coal, and

the Big Coal; and the opposite side of Mine Hill, where we have Johns' Seam, Small 4 feet, and Pinkerton's.

Lewis Dougherty's Colliery, E. Side of Mine Hill Gap.—This mine is in the Daniel Seam, the N. dip of which is from 16 to 20 feet thick. The lower bench gives rather a *pinkish* ash. There is a coal from 7 to 9 feet thick about 7 yards above Dougherty's Big Coal.

The Jugular Coal in Mine Hill Valley burns to a *powdery white ash*, except the *lower* bench, which is a fine pink ash. The dip of Doherty's large vein is from 65° to 70° N.

Charles Hill's Colliery, W. of Mine Hill Gap—Tunnel and Boring.—The first coal cut in Hill's Tunnel is the Daniel, which is 12 feet thick, and in three benches; then 22 yards of hard rock and sandstone, to a coal 5 feet thick in three benches at the end of the tunnel. S. of the tunnel we have 15 yards of slate to a coal 3 feet thick—shafted; 2 feet of coal, the rest bony: then 25 yards of conglomerate and hard sandstone, to a coal 9 feet thick, in three benches: then 16 yards of sandstone to coal 6 feet thick, in three benches; and 25 yards to a coal 8 feet thick, in three benches. This last coal has over it a peculiar fine-grained flaggy sandstone, which we think is the overlying rock of the Jugular. Hill's boring on the top of Mine Hill was undertaken for the Jugular coal; it was down 100 feet, and had cut no coal. The probability is that it started beneath the Jugular Seam. The flaggy sandstone arches to the E. of the bony coal; but at the boring it is cut away, and with it, we suppose, the coal-bed.

McGINNIS'S HOLLOW.

A careful examination of McGinnis's Hollow proves that there is no anticlinal passing there. All the dips, from the conglomerate to McGinnis's Breaker, are S., except a little turn, not seen but inferred, in the position of the Tumbling Coal. (See Section at McGinnis's Hollow.)

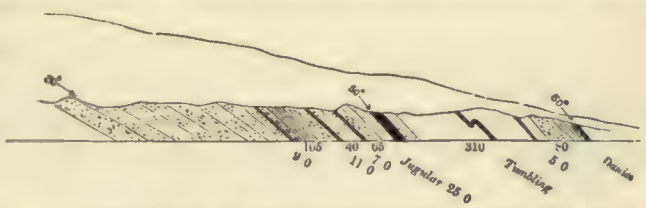


Fig. 185.—Section at McGinnis's Colliery, Coal Castle, looking E. 1 *inch* = 400 *feet*.

Commencing with the Egg-conglomerate, we have a series of coarse sandstones, forming four small ribs, a little conglomeritic. This covers about 100 yards, at an average dip of 30°. We then come upon a coal 9 feet thick, overlaid by a thick mass of conglomeritic sandstone and Nut-conglomerate. The coal-slate is seen directly in contact with the under surface of the rock, which is in sheets from 6 inches to 2 feet in thickness, and weathers grey. The sandstone and conglomerate are about 15 feet (?) thick. The argillaceous and sandy shales, exposed in some shafts, are about 30 feet thick, followed by a ledge of coarse Nut-conglomerate, with sandstone about 50 feet thick. Here comes in a coal-seam 11 feet thick, overlaid directly by dark-grey close-grained sandstone, and above this Pea-conglomerate. This space of about 40 feet brings in the coal 7 feet thick, over which is a heavy ledge of conglomeritic sandstone and Nut-conglomerate, forming a prominent rib some 25 feet thick. This supports the Jugular Coal.

Between the massive conglomeritic sandstone, below the Jugular and that coal, is a mass of coarse sandstone and slate, from 30 to 40 feet in thickness.

Over the Jugular is a coarse dark-grey sandstone and slate, which includes the Tumbling and the Iron coals, which are not marked by any decided ledge, but crop out in the same bench, lying between the top stone of the Jugular and the coarse sandstone and Nut-conglomerate, which occurs some distance below the Mammoth or Daniel Coal. This bed of conglomerate marks the

Southernmost bench, and crops out a little N. from the Breaker. It consists of pebbly sandstone, including irregular layers and nests of Nut-conglomerate in the lower part, and dark-grey sandstone and sandy slates above. The thickness here exposed is about 30 feet. It contains in the upper part many fossil impressions. The distance from the outcrop of the Jugular Coal to that of the Mammoth, along the railroad, is 390 feet, at an average dip of 50°.

Coals at McGinnis's:—

1. The Lelar Coal, 7 feet thick, was wrought here formerly.

2. The Mammoth or Daniel Coal is not wrought on the E. side of the ravine, but is on the W. Its average thickness is from 18 to 28 feet, in two benches; the lower from 4 to 8 feet thick; then 5 feet of slate, variable; then from 18 to 20 feet of coal, sometimes with slate-partings. Dip 35° S.

3. The Five-feet or Iron Coal is not wrought by McGinnis, being faulty.

4. The Tumbling Coal very variable in some places. The good coal is 20 feet thick; but it is generally dirt, not worth working.

5. The Jugular Coal averages from 40 to 60 feet, sometimes of solid coal, and sometimes in several indistinct benches. When distinct, the lower bench is from 6 to 8 feet thick, separating slates only a few inches; the remainder is all coal, with thin slate-partings. The dip of the Jugular is about 45°, becoming less ascending from the road-level to the outcrop. The breast from the road-level to the outcrop is about 120 yards. None of these veins have been wrought below water-level. The Daniel Coal has been mined under water-level as far as McGinnis's Drift Mouth on the W. side of the ravine. The Jugular Coal has been worked E. of the ravine about 175 yards, in a line with the openings on the Jugular at Adams's. It has been wrought W. to the next colliery (Sando's).

6. North of the Jugular is a coal 7 feet thick; 20 yards distant it was not wrought here.

7. North of No. 6 is a coal 11 feet thick; not wrought here.

8. North of this is a coal supposed to be 9 feet thick, but not wrought here.

DYER'S RUN, SANDO'S COLLIERY, ABOUT ONE MILE WEST OF McGINNIS'S.

The Jugular Coal has been worked out above water-level entirely through from this to McGinnis's. The pillars have since been on fire, and the place of this coal is marked by a band

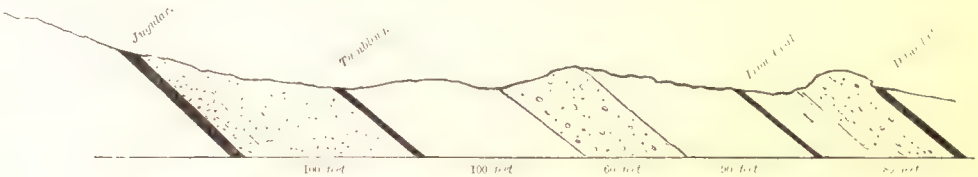


FIG. 186.—Dyer's Run, Sando's Colliery, about one mile W. of McGinnis's.

of burnt ground on the slope of the Mountain on the E. side of the hollow at Sando's. The colliery is on the W. side of the hollow. The direction of the outcrop of the coal from Sando's Mine shows it to be on the Jugular.

Sando's Coal is from 12 to 14 feet thick, with a dip from 45° to 35°, diminishing as we proceed. The work is only begun of late. Its breast farthest in is about 140 feet. The hill here on the S. side of Broad Mountain is lower than to the E., and is covered with debris.

The Tumbling Coal has been opened at McGinnis's, and found to form a kind of saddle or roll on the dip. Is not this the expiring effect of the saddle of the mouth of Wolf Creek, here dying out?

Sando enumerates the coals above the Daniel as follows: The Lelar, Crosby, or Knotwell coals, the Quaker Coal, Willkittie Coal. The Lelar Coal is from 9 to 11 feet thick; the Crosby, 7 feet; and the Willkittie Coal from 7 to 9 feet.

HECKSCHERVILLE SLOPE AND TUNNEL.

Coals.—The *Church* Coal had not been exposed, but was probably 11 feet thick.

The *Crosby* Coal gangway is below water-level; it was driven W. half a mile, and a quarter of a mile E. The thickness of the coal was from 11 to 15 feet, in three benches; the lower one from 4 to 6 feet thick, then a soft undermining about 3 feet; the middle bench 2 feet thick, with a thin parting of bone; the top bench from 11 to 15 feet thick.

The Lelar Coal.—There is a slope on this vein down 86 yards; the gangways ran W. 400 yards, and somewhat short of a quarter of a mile E. The average thickness of coal is 6 feet, in two benches about equal, and separated by 2 inches of slate.

The Daniel Coal.—At the water-level the gangway on this bed runs 1½ miles W., and a quarter of a mile E. The breast is 450 feet above water-level; its average thickness is from 20 to 25 feet, in three benches. The bottom 6 feet of pure coal, then 9 inches bone, and from 2 to 3 feet of inferior coal. The middle bench is from 6 to 7 feet thick, then about 6 inches of bony coal, and an upper bench from 4 to 6 feet.

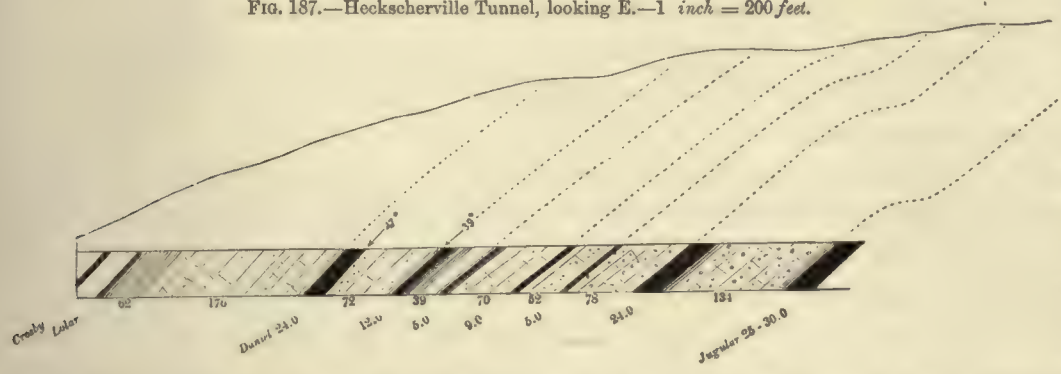
The Daniel Coal is certainly traceable W. to the next colliery (Mecke's) by air-shafts, and from thence by workings on to Staunton's at Glen Carbon.

The coal next N. of the Daniel has been worked by a gangway at the water-level; it was about 3 feet thick; from slate to slate 11 feet.

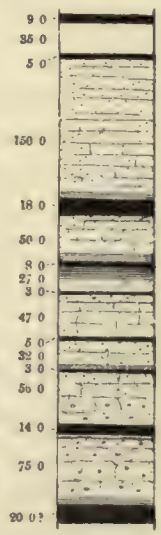
The *Jugular* Coal was worked above water-level by drift; the gangway was driven W. half a mile, and E. a quarter of a mile, or a little over. The breast at its highest point was 600 feet. The average thickness was 30 feet; it sometimes reaches 50 feet in thickness.

Benches.—The top bench is about 5 feet thick; the second about 2 feet of bony coal; the

Fig. 187.—Heckscherville Tunnel, looking E.—1 *inch* = 200 *feet*.



Strata cut in Heckscherville Tunnel. 1 *inch* = 200 *feet*.



third about 3 feet thick; the fourth has about 3 feet of bony coal; the fifth about 4 feet of good coal, and 4 inches sandrock; the sixth has 5 feet of shelly coal; the seventh has 6 feet of coal.

The Jugular and Tumbling Coals are both affected by a flexure; this is no doubt the dying-out of the anticlinal seen towards the E.

THOMASTOWN TUNNEL.

This is a quarter of a mile W. of Payne's Tunnel, on the S. side of the basin. It has been driven S. 180 yards, and cuts only *one* coal 7 feet thick, dipping N. 37°. It was supposed by some to be the same coal cut in Oliver's Tunnel in Peaked Mountain. The distance between the

outcrop of the Crosby Coal of Payne's Tunnel and the North-dipping coal of Thomastown Tunnel is 700 yards. The Thomastown Tunnel is 1370 feet S. of the creek, and about half-way up Mine Hill.

OLIVER'S COLLIERY, PEAKED MOUNTAIN.

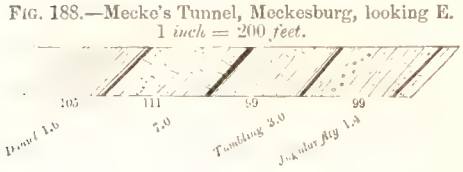
A tunnel here was driven S. into Peaked Mountain. It is a double-track tunnel, which cuts two coals. The first is 10 feet thick, and the Back Vein is 16 feet thick. The Back Coal is probably the Big South Coal of Staunton's Tunnel and the Crosby of Payne, as the following considerations imply :—

It is 94 yards in Staunton's Tunnel, between the Daniel and the Big South Coal. The Superintendent at Oliver's says he has shafted on Peaked Mountain, and found coal 7 feet thick at about the same distance behind the Tunnel Back Coal. It has a fine sandstone top corresponding with the Daniel Coal. He has also shafted 3 feet of dirt-coal about midway between the Back Coal and the supposed Daniel Coal, corresponding with what is seen in Staunton's. The dip of the Back Coal in Oliver's Tunnel is 50° N. ; the dip of a coal 10 feet thick is 52° ; the dip at the mouth is 54°. The gangways on the Back Coal run E. 175 yards, and W. 900 or 1000 yards. On the bed, 10 feet thick, the gangway runs 30 yards E. and 100 W. There is thin conglomerate between the 10 feet of coal and the Back Coal, composed of nut and pea-sized pebbles.

MECKESBURG—MECKE'S WESTERN TUNNEL.

This tunnel starts N. of the *Crosby* Coal, and cuts about 20 yards to the outcrop of the *Daniel*, then 25 yards to the 7 feet of coal of Staunton's Tunnel, 37 yards 2 feet to a small bed 3 feet thick, 50 yards to the Tumbling Coal, and still Northward about 30 yards to the Jugular. The dip is about 45° S. throughout : then from 25 to 30 yards to the coal beyond the Jugular, in the Eastern Tunnel, to coal 5 feet thick, 3 feet of which is good coal.

FIG. 188.—Mecke's Tunnel, Meckesburg, looking E.
1 *inch* = 200 *feet*.



The thickness of the *Daniel* Coal is from 6 to 7 feet. In the tunnel it was only 2 feet thick, but a gangway was driven W. about 350 yards, and at 60 yards the bed was of its regular size. The next or 7-feet coal is the same as in Staunton's gangway W. 400 yards.

The *Tumbling* Coal varies from 2 to 10 feet in thickness ; it had no gangways driven.

The *Jugular* Coal is from 4 to 20 feet thick, its average thickness being 18 feet : it is sometimes faulty ; the fault runs N. and S., and affects all the coals on Mecke's property. A gangway was driven only a short distance.

A 5-feet coal was not reached in the Western Tunnel. In the Eastern Tunnel the gangway was driven 900 yards W.

The overlying rock of the Daniel Coal is a fine sandstone : over the Jugular Coal is a Nut-conglomerate and sandstone ; and *under* the Crosby Coal is slate all the way to dirt-coal in Staunton's Tunnel, except a little shelly sandstone.

GLEN CARBON—STAUNTON'S TUNNEL—DUNDAS TRACT.

This tunnel is driven Northward 54 yards to a dirt-vein, averaging from 5 to 9 feet in thickness. The miners ran on this 54 yards Westward, and then tunneled N. and S.: 54 yards N. of

the dirt-bed they cut the bottom slate of the Daniel Coal, which vein is 16 feet thick there, but is usually from 6 to 7 feet. Before reaching the Daniel Coal, two small leaders were cut, one 18 feet S., and the other about midway: the former is always over the Daniel Coal; its dip is about 45° S. from the Daniel bed: the tunnel runs 16 yards N., and cuts a 7-feet vein, with 3 feet of workable coal—the rest is bone coal.

Thirty-five yards S. from this dirt coal (thought to be Payne's Lelar or Slope Coal), a coal from 16 to 18 feet thick, said to be Payne's Crosby Coal, was tunneled and cut; dip 60°. (Is it not the Black Valley Coal and the Dirt Coal—the Black Heath Coal?) The distances here correspond well with those in Payne's Tunnel.

The gangways on the *Daniel* Coal were driven 1000 yards W., not E. at all. The Daniel Coal lies in four benches, with but one parting of slate; the rest is bone.

The gangway on the 7-feet Black Coal was driven W. from 350 to 400 yards. There are five benches, two of workable coal, the rest of bone.

On the *Crosby* Coal, the gangway was driven W. 900 yards. The coal usually lies in four benches, but sometimes in only three, with slate partings. The dips are more rapid in these gangways in going W. The coals are all *White Ash.*

ROHRERSVILLE—ROHRER'S MINES.

At this colliery six coals are opened in all. The 1st or lowest saddle is on the turnpike, or a little S. of the highest part of the ridge. It has 18 feet of good coal, 500 yards above water-level.

The 2d Coal crops out 70 yards S. of the outcrop of the 18 feet of coal; its thickness was not known; it is a rough hard coal.

The 3d is a coal one yard thick, soft and faulty. It is 50 or 60 yards S. of No. 2.

The 4th is the Roan Coal, 17 feet thick; it yields about two-thirds good coal, and has one yard of slate in it; dips 50° S. It is about 170 yards S. of the Saddle Coal, No. 1.

The 5th, from 12 to 15 yards S. of the Roan Coal, is 3 feet thick, and soft.

The 6th is 3 yards S. of No. 5, and is one yard thick; all S. dip. In a tunnel driving N. near the old sawmill they have cut four coals within a distance of 50 yards (1852).

PEAKED MOUNTAIN AND BUCK RIDGE ANTICLINAL, AND LIMIT OF COAL IN BUCK RIDGE BASINS NORTH AND SOUTH.

Proceeding to the end of Buck Ridge, on the S. slope, at Rohrer's Mines, we behold the upper Egg-conglomerate cropping out on a S. dip; crossing the end of the ridge Northwards, sandstone dips 12° S.; and continuing on, we come upon the N. dips of the same rocks on the N. flank of the ridge, which leads to the conclusion that the anticlinal axis occurs in the N. crest of Buck Ridge. Following this N. dip of the conglomerate Eastward to the creek, we find that it forms the N. dips of the W. end of Peaked Mountain, which may be followed along the axis to the turnpike. The axis seems flattened at the road. The Peaked Mountain axis of Rohrer's Mines appears to be but feebly felt at Oliver's.

From an examination of the rocks between Mine Hill and Buck Ridge, the conclusion arrived at was that the coal does not extend even so far W. as the head of Buck Run.

On the N. side of Buck Ridge we may see the upper Egg-conglomerate in the bed of the

creek, and above this, sandstones dipping flatly to the N.E.; and farther on, other sandstones dipping S.E. 45°.

There is probably more coal in this basin further W. than in the basin S. of Buck Ridge.

BUCK RIDGE AND PEAKED MOUNTAIN ANTICLINAL.

This is the bold anticlinal which forms the high ridge N. of Mine Hill, merging from Mine Hill at a point as far W. as Swatara Creek, and very gradually sinking Eastward: it forms the important axis which, as far E. as Meckesburg, divides the Mine Hill Basin into that included between it and Broad Mountain, and the other between it and Mine Hill. At a point about three-fourths of a mile S.W. of Tobias's Mount Pleasant Tavern, the axis is arched by the great lower Egg-conglomerate, with N. and S. dips of about 30° each. Traced Eastward, it is found to be saddled by somewhat higher measures, and at the E. end of the so-called Buck Ridge we find the sandstones and smaller conglomerates which overlie the great upper Egg-conglomerate forming a conspicuous saddle. Here, however, the axis appears to occupy the N. brow of the ridge.

By a careful tracing of the N. dips of the great Egg-conglomerate, exposed at the E. end of Buck Ridge, across the swamp to the most Western end of Peaked Mountain, they are seen to correspond exactly with the North-dipping measures of Peaked Mountain; and although the course of Peaked Mountain is not at all that of Buck Ridge, the fact would seem to be clearly established that they are formed by the same great anticlinal which, as it declines suddenly, elbows more towards the S., and, arching higher and higher coals of the White-Ash series, seems finally to disappear entirely, in the topography of the country, about one-fourth of a mile S.E. of Meckesburg.

The exact position of the Peaked Mountain anticlinal is discernible on the turnpike road which crosses the ridge near the Rohrersville Colliery. It is almost at the flat low crest of the ridge, a little more than half a mile S.E. of the Mount Pleasant Tavern. Here the lowest of the Rohrersville coals makes a saddle across the axis: it is 18 feet in thickness. On the S. side of the anticlinal seven other coals have been opened, five of which, in the vicinity of the Rohrersville Colliery, prove to be of workable thickness, one of these, Raun Vein, being in all 17 feet thick, but containing of good coal only 3 or 4 feet. The dip of this bed is S. 50°. The remarkable deflection in the anticlinal of the Buck Ridge, to prolong itself as that of the Peaked Mountain, suggests naturally a somewhat different view of the structure of the ridge at this place of seeming dislocation, where the abrupt change in the trend of the ridge takes place. So great an elbow in an anticlinal can hardly exist without considerable twistings and warping of the strata, and is most apt to be connected with a doubling of the axis, producing one or more intermediate dislocated troughs or undulations; and such is possibly the case at this locality. This wrenching of the axis indicates, in other words, a lapping of one anticlinal point past another, a phenomenon displayed on a grand scale in some of the great axes of the Upper Juniata, in Huntingdon County. Considering the Buck Ridge and Peaked Mountain anticlinal as one, we may still, in accordance with this idea, adopt either of two notions respecting the manner in which it makes its elbow—either that the Buck Ridge axis prolongs itself N. of the Western end of the Peaked Mountain portion into the Northern Branch Basin;

or, what appears to be more probable, that the Peaked Mountain axis, extending Westward, passes to the N. of the Eastern end of the Buck Ridge portion. For a clearer understanding of this anticlinal, the reader will consult the Map. It becomes here an interesting question, how far Westward this Western point of Peaked Mountain axis may enter the Northern Branch Basin on the Hartman Tract. It is difficult to conceive that so marked an anticlinal can either expire so soon, or bend so suddenly, as not to produce some elevation of the strata towards the centre of that basin.

OF THE SOUTH-WESTERN BRANCH OF MINE HILL BASIN.

Of the coals which enter Westward from the main Mine Hill Basin, its Southern branch, or that embraced between the Mine Hill anticlinal and the Buck or Peaked Mountain axis, no very precise knowledge has yet, in the infancy of mining there, been attained. That the Daniel or Great Mammoth Coal, and those adjoining it, do not enter this subordinate basin far, but swing their outcrops Northward from the base of Mine Hill to the point of Peaked Mountain, and then inflect them Westward along the Southern side of the Northern Branch Basin, seems to be the prevailing conviction of those who are working these coals to the Eastward, and all who are best informed respecting the features and structure of the district. If such be really the state of things, it is obvious that none but the lowest White-Ash coals, or those between the horizon of the Jugular and the upper Egg-conglomerate, can have a place in this trough. It is pretty certain that no coal-seam—none, at least, of workable size—can extend as far as the head of this basin, which is only half a mile E. of the watershed of the Swatara Valley, for here the sandstone over the lower Egg-conglomerate, which is below any minable coal, itself forms the bed of the valley, and therefore the more available coals overlying the upper Egg-conglomerate can have no existence so far to the Westward.

The great White-Ash coals, the Mammoth and Jugular inclusive, enter this basin some distance Westward ; the Jugular, however, grows thin and faulty even at Meckesburg, while the Daniel (Mammoth), Crosby, and contiguous coals, stretch on Westward on the N. side of the basin at the foot of Broad Mountain, beyond the Glen Carbon Colliery ; but how far, has not been positively determined by actual mining further than some 1500 feet W. of the Glen Carbon Tunnel. The outcrop of the Daniel Coal has, however, been identified, it is believed, almost as far Westward as the forking of the turnpike near the Mount Pleasant Tavern. That this vein prolongs itself into the Hartman Tract, outcropping, however, not so near the margin of the valley, is quite probable ; but the mining operations now commenced in this quarter will soon settle this locally-important question. The Crosby, a higher coal, cannot of course extend itself as far to the Westward as the underlying Mammoth Vein ; while the Jugular, a lower but much more fluctuating coal, having its outcrops on the slopes of the ridges, will necessarily, if it exist at all as a traceable or workable seam, throw itself considerably further forward before it basins out in turn towards the head of the valley. All of these coals are of course to be found on the S. side of the basin at the foot or on the slope of the Peaked Mountain and Buck Ridge ; but the coals there mined in Oliver's Peaked Mountain Tunnel have not thus far been positively identified, though an impression prevails among the experienced that Oliver's 16-feet Vein is the equivalent of the Crosby of the Broad Mountain side of the basin.

How far Westward any productive coals extend towards the head of this valley, present developments do not determine; but sandstones overlying the upper great Egg-conglomerate have been detected by us $1\frac{1}{3}$ miles S.W. of the Mount Pleasant Tavern. Thus far the lowest coal-seams may probably extend in a contracted synclinal point, and their furthest prolongation will be found, we suspect, along rather the S. side of the valley—a natural consequence of the greater steepness of the N. or Buck Ridge dips, over the S. dips at the foot of Broad Mountain. However, it must be observed, that W. of our Section, and a little N. of the stream at the foot of Buck Ridge, flattish dips to N.E. are seen in sandstone; while further Northward a few hundred feet, another sandstone plainly exposes a steeper dip of 45°, directed towards the S.E. This last-named high dip, taken in connection with the still steeper inclination of 50° S. in the newly-opened 12-feet coal of the N. side of the basin, some 400 yards W. of Mount Pleasant Tavern, is certainly an encouraging feature respecting the depth of the Coal-measures, and the amount of coal in this W. portion of this Northern Branch Basin.

The coals opened (down to the date of the autumn of 1852) on the Hartman Tract, on the N. side, with S. dips of from 45° to 50°, are,—

First in ascending order, a rough coal, 4 feet thick. This will probably yield not more than $2\frac{1}{2}$ or 3 feet of good coal.

Second, a good coal, 11 feet thick, dipping 50° S. This promises 9 feet thickness of good coal.

On the opposite or S. side of the basin three coals have been opened; they dip 80° N. The uppermost of these, all of which are more or less compressed and faulty, is squeezed at its outcrop to a thickness of 3 or 4 feet, but further down it is said to be 6 feet thick.

The next under it crops out Southward about 30 feet; and S. of this again, 20 feet further, rises another seam. I forbear to give their dimensions until they shall have been more thoroughly explored.

CHAPTER XIII.

DESCRIPTION OF THE MORE IMPORTANT COAL-SEAMS OF THE SOUTHERN COAL-FIELD, WITH THE DUPLICATE NAMES WHICH MANY OF THEM BEAR.

I HAVE devoted much pains, in the progress of the geological survey of the anthracite region, to noting and recording the characteristic features of the individual coal-seams, to tracing the variations of type which they undergo, to ascertaining their identity from section to section, and the double names which many of them possess. From the circumstance that, from the commencement of mining operations, in the S. basin especially, down to the present day, the chief collieries and explorations for coal have started in the valleys which intersect the basins, the identity of the beds, from valley to valley, remains even yet imperfectly known. In the absence of such knowledge of the equivalencies of the locally open beds, it was natural, indeed inevitable, that the miners should assign either local names, or apply the known names of distant coals erroneously, to their own favourite seams. A desire to apply to a newly-found coal, or a newly-organised mine, the name of some bed of established repute nearly in the same range with

it, where a scrupulous tracing of their outcrops might have proved them dissimilar, has added not a little to the excessive confusion of nomenclature which now exists, to the serious detriment of the mining interests of the region.

Not a few of the disastrous disappointments which attend mining enterprise in the Pottsville Basin may be attributed to the prevailing ignorance of the true range and identity of its coal-beds, one main source of which, next to a want of clear tracing of the anticlinal and synclinal flexures, is the confusion in the naming of the coal-beds.

In the hope of repairing this lack of knowledge, I have annexed to this chapter on the individual coal-seams, some important notes upon the identity of the coals known under different names.

DESCRIPTION OF THE SEVERAL COALS.

Coal A of Tamaqua.—The bottom rock of Coal A at Tamaqua is a heavy Nut-conglomerate, with a breast of 700 feet, and dipping at the river about 65°. A tunnel is driven to it at Reinhardt's Run. The thickness of the entire bed at the river is 16 feet; it is not worked to the E., and nothing therefore is known of it in that direction; but to the W. the gangway extends in for about 350 yards. This coal appears to be all in one body, with no parting-slates, but a good deal fissured and rubbed.

Three coal-seams have been found N. of Coal A, but of these nothing is known to the W., while they are wrought to the E. at Nesquehoning; that behind A is probably the Nineteen-feet bed at Nesquehoning; the next is a 5-feet coal, and the lowest coal is 28 feet thick.

At Nesquehoning there are two other small veins of coal still further N., making in all five beds N. of Coal A, in that region. Only three beds have been discovered here, and these appear to be nipped or contracted at the outcrop.

Coal B of Tamaqua.—The E. side of this bed is not opened; the W. side dips about 65°, judging by the rocks. It crops out N. of the first ledge of conglomerates. The average thickness of this coal near the river is about 9 feet, but on the mountain it is more than 12 feet. It outcrops about half-way up the N. slope of the Locust Mountain. It is worked at the Newkirk Tunnel.

The coal-seam next North of D in Newkirk Tunnel (B or C of Tamaqua) has been driven 400 yards E. and 400 yards W. of the tunnel. This is strong Red-Ash coal. 200 yards W. of the tunnel there is an air-shaft, which is 287 yards up the breast; the air-shaft from the tunnel is 726 feet up the breast. 200 yards E. of the tunnel the air-shaft is 549 feet up the breast. The dips are severally 30°, 28°, and 42°. This coal-bed is faulty to the E., but good to the W.; its average thickness is about 17 feet.

Coal C of Tamaqua.—This bed is faulty on the E. side; its thickness on the river is 6 or 7 feet; on the W. side it is 8 or 9 feet thick, and it still thickens going W. Its dip at the river is from 55° to 58°. It has been driven in a W. direction about 900 feet.

This coal-seam exhibits, in an ascending order, clay-slate at the bottom, overlaid by 2 feet of good coal; then 6 inches of slate, above that 2 feet of good coal; next, 6 or 7 inches of slate; and then 3⅓ feet of coal, overlaid by slate.

Coal C, cut in Newkirk Tunnel, was there pinched down to 20 inches.

The bed North of Coal D in Newkirk Tunnel, already referred to, is no doubt the bed C of

Tamaqua, and not B, as was supposed. Ratcliffe's line of air-holes on D, west of Tamaqua, are extended to nearly opposite the end of Wigan's working in the disputed vein Eastward of Reinhardt's Run. The interval between the two ranges of outcrop is nearly the same as that between C and D at Tamaqua.

The Coal C at Tamaqua is underlaid by about 4 feet of slate, below which is a thin coal-seam not wrought. In the mine at Newkirk Tunnel, the slate-bed is reduced in thickness, and becomes a slaty coal; and the underlying coal, here 3 feet thick, is wrought with the rest. This bench yields a strong pink ash. It is interesting to ascertain whether the bench below the slate at Tamaqua would yield a coal of the same kind.

Coal D of Tamaqua.—This bed on the E. side has a thickness down in the slope of from 14 to 16 feet. It has been driven E. 1400 yards in the old upper level, where a rock-fault was approached which heaved the vein off to the S.E.

This bed displays on the top level, in an ascending order, hard clay-slate; then 3 feet of clean hard coal; next, 6 inches of slate; above this, 4½ or 5 feet of long-grained streaky coal; then 1 foot of rough bony coal, overlaid by 2 feet of slate.

At a depth of 385 feet below the top of the slope is found, in an ascending order—first, clay-slate; above that, 7 feet of clean hard coal; next, 6 inches of slate; over this, 8 feet of good coal; then 1 foot of rough coal; and on the top 2 feet of slate coal, with *Stigmaria* in the coal.

The dip at the bottom of the slope is 68°, at the top it is 56°.

On the W. side Coal D has been driven through to Reinhardt's Run on the top level. The coal is nearly the same on the top level as at the E. side, both in quality and thickness, but flattens in pitch. At Reinhardt's Run the dip is only 42°. The height of the breast is 280 feet from the upper level; when on the hill it is 420 feet.

Coal D has been cut in Newkirk Tunnel, and also in Greenwood Tunnel.

At Buckville Tunnel the next bed N. of Coal E has been worked W. about 170 yards. It is separated here from the Cross-cut by 10 feet of slate. They are here wrought together.

Coal E of Tamaqua.—This coal-seam has been driven through towards Reinhardt's Run to within 300 yards of the Reinhardt's Run gangway, or 600 yards from the tunnel, in which it is cut and found pinched. The breast on the last air-shaft of E is 420 feet. The dip is here about 55°, but at Reinhardt's Run 42°. It flattens very little towards the outcrop. Sometimes there are four or five benches on the E. side.

The coal-seam E of Tamaqua exhibits, in an ascending order—first, soft shale; then 4½ feet of clear hard coal; afterwards, 9 inches of slate; upon this, 12 feet of long-grained streaky coal; next, 12 or 15 inches of slate, overlaid by 3 feet of good coal; then 2½ or 3 feet of slate; and on the top, sandstone grit.

Towards the W. this seam runs rather faulty. On the E. it has been worked through to the Greenwood Tunnel, in which it is cut, and rates at about the same dimensions. At Reinhardt's Run it is reduced in dimensions. In Newkirk Tunnel it is found pinched, but to the E. it retains its thickness.

This coal-seam is now worked through from Tuscarora to Newkirk Tunnel. In the tunnel it is only 12 or 15 inches; it has been worked E. about 800 yards; at 400 yards, about 12 or 15 feet have been wrought; and at 600 yards, 30 feet have been worked. It then declines to 12 or 15 feet.

Coal E at Buckville has been worked E. from the tunnel 600 yards, and the same distance W. The thickness of the coal is about 18 feet. On the level, 300 yards E. of the tunnel, it is driven across to the "Cross-cut" seam.

In the Palmer Tunnel, a big seam, considered to be the same as E of Tamaqua, has been cut 97 yards N. of the Palmer. It has been driven 200 yards E., and about 125 yards W. The dip in the tunnel is 65°, E. of the tunnel it declines to 45°. W. of the tunnel it is unchanged. The average thickness is 20 feet, and the height of the breast 285 feet.

Cross-cut Coal of Tamaqua.—This bed is only 12 feet S. of Coal E, and at Reinhardt's Run it is 45 feet; it is probably the principal bed at Buckville. In Newkirk Tunnel it is 2½ feet thick, and in Greenwood 10 feet.

Sixty feet W. of Newkirk Tunnel it consists of 2 feet of hard glassy coal, capped by one foot of Bird-eye coal. It is largely wrought on account of its purity.

Coal F of Tamaqua.—This bed at the water-level is 90 feet lower than the same in Newkirk Tunnel. At Reinhardt's Run it dips 50° S., flattening towards the synclinal axis, the dip being 42° in the bottom of the slope, and 38° at the top. The seam is in two benches. The bottom bench is thickest on the E. side of the river, being 6 or 7 feet, while on the W. side it is 5 feet. The top bench is 7 or 8 feet thick on the E. side, and 6 feet on the W. side. It is cut in Greenwood Tunnel, and mined Eastward for about 1½ miles in the tunnel-level. A slope-mine enters into it at Carter's New Slope 3000 feet E. of G Tunnel, 500 feet down from the surface. The bed is there from 12 to 15 feet thick, and consists of Pinkish Grey and White-Ash coal. It dips 50° S. The 8-feet lower bench is Pink Ash. This appears to be the Eleven-feet Coal in Tunnel No. 8, or first above the large White-Ash seam on Panther Creek. It has been worked E. from Newkirk Tunnel one mile above the water-level. In the gangway, 450 lower, it has been worked E. 1800 feet. It has been worked W. from the tunnel, above the water-level, 600 yards, where a rock-fault comes in. In the level, 450 feet lower, the same fault was struck at 300 feet in working W. 300 feet have been driven in the fault.

It has been connected with Coal F at Tamaqua by a hole 60 feet deep from the end of Newkirk Level. The dimensions at the tunnel at Newkirk are 7 feet; 300 feet E. of the tunnel, 17 feet; and 600 feet further on, 22 feet. This continues to the end of the level, one mile.

The dimensions are—at the tunnel, 11 feet; 600 yards W. of the tunnel, 20 feet; then it is nipped. On a rise, 90 feet above the level, it is 40 feet thick, and faulty.

The bed called the Palmer Vein, cut by a tunnel driven N. from the Slope at Tucker's Slope, and cut in the Palmer Tunnel, is no doubt the F of Tamaqua. At Tucker's Slope it has been wrought about 4200 feet W. of Tamaqua, where it struck a rock-fault. It was driven E. about 800 yards, or within 75 feet of the line of Schuylkill County.

A slope has been put down on this bed, 285 feet E. of Tuscarora (Tucker's) East line. This is known to be the outcrop of the F Coal of Buckville, and therefore of Tamaqua. In the Palmer Tunnel this bed is from 12 to 14 feet thick. It has been driven on E. 600 feet to the line, and W. about 2400 feet to a fault, which appears to have heaved the bed towards the N. about 60 feet.

This bed is 138 feet S. of Coal F at Tamaqua, and is there 6 feet thick. It is cut in Newkirk Tunnel, is 3 or 4 feet thick, and in Greenwood Tunnel is 6 feet. In Buckville Tunnel it is 5 feet, and has a dip of 35° S.

Buckville.—Here the slope W. of the mouth of the tunnel is down 318 feet. The dip is 40° or 45° S., and the thickness from 10 to 12 feet.

A little more than half a mile E. of Tuscarora village is the coal of Tucker's Slope. It is 450 feet to the bottom of the slope, 270 feet below water-level. It has been driven 135 yards Eastward, and 1200 yards to the W. A remarkable dislocation was encountered at the end of the E. gangway.

Bowman's Slope on Reinhardt's Run displays in an ascending order—first, 5 feet of good coal, then 3 inches of coal-slate, next 4 feet of good coal a little faulty, overlaid by one foot of top clod.

Grier Coal of Tuscarora.—The bottom bench of this coal is Red Ash, and is 20 inches or 2 feet thick; the top bench is 3½ feet thick, and is Grey-Ash coal.

This coal-bed is worked by a slope at the Newkirk Colliery on Reinhardt's Run, at a distance of 105 yards S. of Coal F in the tunnel there. At Reinhardt's Run it is called Bowman's Big Coal. Here it is a Pink-Ash coal, its regular thickness being 9 feet. 100 yards E. of the tunnel there is a fault in the rock. In this distance it varies from 9 to 40 feet in thickness. The dip at the slope on Reinhardt's Run is 40° S.

Tuscarora Coal of Tuscarora, supposed to be the Palmer.—This coal is said to be in two benches: the lowest, 4 feet of Red Ash overlaid by 4 inches of slate; the upper, 7 feet of Grey Ash, with a roof of fireclay.

Big Coal, or Mammoth Coal.—This cut is in Whitfield's Upper Tunnel, on De Long Tract; the average thickness there is 8 feet, being sometimes 11 feet, and often only 6 feet; it consists of three benches, and slate between the upper and middle benches: the top bench is sometimes rough, but the bottom one always pure. In these features this bed resembles that at Big Creek. The length of the gangways to the E. is 1200 feet; to the W. it is 3000 feet; the coal is faulty, and is from 10 to 20 feet thick.

At Casca William this coal-bed is about 18 feet thick, and has an average dip of 61° in the slope. The gangway on the lower level has been driven about 3000 feet Westward, and chiefly from the slope.

At Silver Creek the Big North Coal is the same as the Big Coal of Casca William. This is proved by the line of air-shafts which correspond.

Black Heath Coal.—At Casca William this bed averages about 10 feet thick, and dips 60° S. It is composed of Grey-Ash coal. The tunnel is 84 feet S. from the Big Coal bed. The gangway is about 1500 feet long. Between the Big Coal bed and Black Heath bed there is a pebbly rock.

It is same as the Big Coal bed of Silver Creek. It is worked by Miller's Slope on the Big Seam at Mount Laffee. It is 12 feet thick, and dips 55° S.

Also in the tunnel, at the foot of Heilner's Slope on Wolf Creek. Here the coal is 4 feet thick.

Also in Serril's Upper and Lower Tunnels, between Wolf Creek and West-West Branch.

Under the same name, though perhaps falsely called, it is worked at Middle Creek by drift, and at Donaldson by gangway in the tunnel.

This is probably the same as the Lelar of Mine Hill Valley, and the dirt-bed of Staunton's Broad Mountain Tunnel.

Skidmore Coal.—At Casca William this seam is 47 feet N. of the Big Coal, and is 4 feet 9 inches thick.

It has been cut in Mount Laffee Tunnel on West Norwegian.

Jugular Coal.—This seam averages from 40 to 60 feet in thickness at M^c^Ginnis's Colliery. It is sometimes solid coal, and sometimes in several indistinct benches. When distinct, the lower bench is from 6 to 8 feet thick, and the intervening slates only a few inches; all the rest is coal, with thin slate-partings. The dip is 45°, becoming less as it is followed up. It consists of a very powdery White Ash Coal; the lower bench is a fine Pink Ash.

It has been worked by gangway at Payne's Colliery in Mine Hill Valley, where the average thickness of the coal is 30 feet, and also by gangway at Sando's, on the W. side of Dyer's Run. On the E. side it has been burning for many years past.

It has been drifted upon at M^c^Ginnis's on Broad Mountain.

It was supposed to be cut at the end of Adams' Tunnel north-east of Mine Hill Gap.

It has been cut in Mecke's Tunnel, where the average thickness was 18 feet, and also at Lawton's Mines.

Black Valley Coal.—At Casca William, 42 feet S. of the Black Heath, this coal, which is Grey Ash verging on Red, is 7 feet thick, and dips 55° S. The gangway is driven about 675 yards Westward. It is cut and worked in the Old Mount Laffee Tunnel.

It is also worked in the slope on West Branch at Mine Hill Gap.

It is cut in Jones' Tunnel south of Jones' Slope, and has gangways in it driven E. and W.

It is cut in the tunnel from the foot of Heilner's Slope, Wolf Creek.

It is also cut in Serril's two tunnels at the head of Wolf Creek.

It is mined in a slope-pit on West-West Branch under the name of the Forestville Coal.

This is cut at the back end of Edwards and Morgan's Tunnel, on the Forest Improvement Company's lands. It is worked by gangways at the new mines, where it is called the "White-Ash Vein."

It is worked by M^c^Creary at Swatara Falls and at Middle Creek under the same name, and is said to be the same as that worked at Donaldson under the name of the Gardner Seam, and cut in the tunnel there, and sometimes called Holmes' Vein. It is probably the same as the Crosby Seam of Mine Hill Valley.

Little Peach Orchard Coal.—This is worked on the West Branch by a gin slope under the name of Oak Hill Vein. It has also been worked on Wolf Creek in a slope by Holman and Company, where it is from 8 to 10 feet thick; and also on the W. side of Wolf Creek, in a slope, by Richard Kear. Hence to the W. it is frequently called Kear's Vein.

Primrose Coal.—Worked by Jones and Mason on East Norwegian by two slopes on the N. and S. sides of an anticlinal. It is 4 feet thick.

It has also been worked by Morgan Brace on West Branch under the name of Morgan Vein.

It has been worked in a slope by Heilner, at the head of Wolf Creek, under the name of Bast White-Ash. It is from 6 to 12 feet thick.

It was worked by Bast and Pearson on the W. side of Wolf Creek. There is a slope upon it. The coal is 8 feet thick.

The Primrose Seam of Mill Creek had on the E. side of the working a bottom of 3 feet of

bony coal, and 6 feet of good coal, but worked more to the W.; it contained from 12 to 14 feet of good sound coal.

The Primrose Seam is cut in Ravensdale Tunnel; the coal is there 7 feet thick. It is cut again at the end of the tunnel, where it is, however, dirty.

South Diamond Coal.—The Red-Ash Slope at Casca William, called the Luther or South Diamond Seam, has a gangway worked Eastward on the S. dip below water-level to the Hubley Tract. They have worked it up to the line of the Bushy Tract. The same coal on Bushy Tract is the second N. of the Lower Breaker, and the first S. of the ravine. It is worked through, and dips at about 55° or 60°. The dip varies, and at Daniel's is in steps. It contains clear good Red-Ash coal 5 feet thick, with a strong rocky 2-inch slate in it. The dip at the slope is 50°. It is flatter on the same level further W.

At Mill Creek the South Diamond Coal is 4 feet thick.

The South Diamond Coal, drifted from Crow Hollow eastward a short distance, is not worked on the W. side.

Big Diamond Coal.—The Big Diamond Coal of West Branch and Wolf Creek is not the true Big Diamond of Norwegian. Under that name, however, it has been drifted upon on West Branch, and was worked in 1852 by Bast and Pearson, in their slope on the W. side of Wolf Creek, where it dips S., and is 5½ feet thick.

The Big Diamond of Mill Creek is worked there by a slope, which is 450 feet down, and is 7 feet thick.

It is found to flatten in dip as it descends. About 200 feet below water-level it is flat, and then turns up. At the flat part it is more than double the ordinary thickness, but in rising on the N. dip it is crushed and worthless, and very thin.

The Big Diamond Coal is called the Green Park on another dip.

Little Diamond Coal.—A seam is worked under this name on West Branch by drift; on Wolf Creek by Heilner's Slope, and on West-West Branch by Miller's S. Slope. It is supposed to be the Big Tracey Seam, being, however, two seams under Morris's Peach Mountain of West-West Branch.

Palmer Coal.—At Milford Colliery, the so-called Palmer Vein on the S. dip is gently inclined, being not more than 18° or 20°, and is a thin coal, rarely 2 feet thick; it has therefore not been wrought far to the E. It has been worked 500 or 600 yards W. on the upper and lower gangways. On the N. dip the Palmer stands nearly perpendicular, but far E. and at the tunnel it is not so steep. It has been worked 900 or 1200 feet E. from the tunnel, and shows good coal, varying from 20 inches to 2½ feet thick, all dipping S. It has been worked at the N.E. side of Middleport by Patrick Freeman, on Hensinger's property. At Mill Creek it has been wrought by Mason and Spence by drift, and contains about 3 feet of good coal. It has also been worked on Lick Run.

Charles Pott Coal.—At Milford Colliery this seam is entered by a drift just at the mouth of the tunnel; it dips 55° S. It is worked out and closed up. The slates outside show a S. dip of 35° or 40° from the pressure of the hill.

It consists of 2 feet of good hard coal, with rock at the top and slate at the bottom. It is worked nearly as far as the Clarkson. In the tunnel it was, in 1853, only worked 45 feet each way. It dips 35° or 40° S., and is steeper Eastward. It has been worked to the E. by Dr Steinberger, and at Middleport by Billy Wall.

It has been worked W. of Middleport by Hebner. It dips S. The coal, 2½ feet thick, was not good, being faulty.

At the Five-mile Board it was worked by Bosbyshell in 1838, and by E. Collahan in 1850. Good coal 3 feet thick was found dipping S. It has been wrought by T. Williams at Lick Run, where it showed from 3 to 3½ feet of good coal, with tough blue upper slate.

Clarkson Coal.—At Milford Colliery this coal-seam dips S. It is entered at the water-level below the Breaker, and has been worked E. about 1100 or 1200, or probably 1300 yards, as far as the farmhouse S. of Patterson. There is a gangway in the old field E. of the farmhouse. The outcrop passes here to the N. of the house. This coal-seam has generally a gentle S. dip, but at the N. end of the slope it is about 55°. Here, at 75 feet below the water-level in the slope, there is a rock-fault, with a sudden upcast of 75 feet, entirely cutting off the coal, without even a leader—an unusual thing in this coal-basin. It is 5 feet thick, and was worked by Billy Wall at Middleport.

This coal-seam was opened and identified at Middleport by Mr Thompson; it dips S., and has 3 feet of coal and 3 feet of dirt; with a bone coal and slate top. It has been worked as far W. as Cwmbola, where Bolton worked it by a slope as far as Milford. It was shafted upon at intervals, and worked at Milford by S. Silliman.

Peacock Coal.—It is probable that the Lower-slope Coal of Miller on West-West Branch, known as the Cockle Vein, is the Peacock Coal of Mill Creek.

Yard or Clinton Coal.—The little seam between Miller's two slopes on the West-West Branch is probably the Yard Coal of Mill Creek, supposing the S. slope seam to be the Big Tracey Coal.

Big Tracey Coal.—The Little Diamond, so called, of the West Branch and Wolf Creek, as worked at Heilner's Slope, and of West-West Branch, as worked in Miller's S. Slope. It is the second vein under Morris's Peach Mountain Coal: it is therefore the Big Tracey Coal.

Little Tracey Coal.—This seam is shafted upon W. of Middleport. It dips S., and is 2½ feet thick. It has under it an Egg-conglomerate. At Valley Furnace it has been worked by Davis and Williams, and is 2½ or 3 feet thick. It is supposed to be the Platt Seam, which is tunneled to from Spencer's Slope on Wolf Creek.

Peach Mountain Coal.—This seam has been worked W. of Middleport on both dips of the synclinal on A. Stahl's Tract west of Casca William Tract. Its basin rises W. It has been worked by George Thompson, who feels sure it is the same as at Pottsville. At Middleport it is from 2½ to 4 feet thick, with a fine leafy roof and slate bottom 7 feet thick, under which there is a small rough seam, having the appearance of "baked bread." It has no grains of lamination, but "looks like twisted dough." It is a rather pinkish Red-Ash good coal. The same parting-slates are recognisable, but thinner.

The small coal under the Peach Mountain Coal is well known at Pottsville; it has an inch and a half of a dull coal, like coarse cannel coal, for its top plait, both at Middleport and Mill Creek. This seam has been worked at Capewell and Dovey's Slope on Silver Creek. It has also been worked on Wolf Creek, on the S. dip by a slope, under the name of the Spencer Coal; also by Heilner in drift, under the name of Kantner, on the N. dip on Wolf Creek; and formerly by Spencer at Minersville in Lewis's Old Tunnel; and since by Morris on the West Branch under the name of "Fire Vein." It has also been worked at the Delaware Mines on West Norwegian in a slope.

Spohn Coal.—This bed has been worked at Middleport by H. Uren on the S. dip. It was from 6 to 7 feet thick, and when faulty was down to 2 or 3 feet, and had the same roof and slate as at Belmont and Centre Turnpike.

It was worked S. of New Philadelphia by Connor and Roads. The slope upon it dips 30° or 35° S. The coal is 4½ feet thick.

It was cut in the tunnel driven from the foot of Milnes and Snyder's Lewis Slope under the name of the "North Vein."

It has also been worked at Branch Dale Colliery on Muddy Branch by M^c^Donald.

The Spohn Coal of Mill Creek is supposed to be the same as the *Palmer Coal* (*Yard*) and Chestnut of Spencer and Mason, and the Engine or Little Gate Coal is therefore the Selkirk.

Some think the Spohn and Peach Mountain Coals are the same, but this is a point not settled.

Lewis Coal.—This seam has been worked by a slope on the E. side of Mill Creek by Snyder and Milnes. It is 4½ feet thick, and dips 35° S. It has two benches.

The Lewis Bed, so called, worked at Belmont and Cwmbola, is in reality the Sandrock of Mill Creek. It was worked on the W. side of Mill Creek by Haven. It is a slope colliery.

It has been worked at Belmont (Five Points) under the name of the Spohn Coal. It dips 37° S., and is 3 feet thick.

It has also been worked in a perpendicular shaft at George Miller's Works on West Norwegian; the shaft is 255 feet down. Also by M^c^Donald at the Branch Dale Colliery on Muddy Branch. It is thought to be the same as the Main Gate Coal.

Sandrock Coal.—This has been opened by drift on the W. side of Mill Creek, but is there found in fault. It is 3 feet thick. It has been mined by slope-working at Belmont (Five Points), under the name of the "Lewis Vein," by Tyler and Agard. It is there 5½ feet thick, and dips S.

It has also been mined by slope-working, by the same firm at Cwmbola, under the name of the Lewis Seam. It is there 4 feet thick, dipping 38° S.

Big or North Gate Coal.—This has been worked at John Preston's Colliery south of New Philadelphia by drift. It contains 9 or 10 feet of good coal. It is the same as the Lewis Coal.

South Gate Coal.—John Preston has worked this mine S. of New Philadelphia by drift. It is supposed to be the same as the Little Spohn and Black Mine Coal.

Black Mine Coal.—This has been tunneled to from the foot of Oliver's Tunnel Coal-slope south of Pottsville, and mined by Fogarty and Brother on the West Branch by a slope. It is thought to be the South Gate Coal.

Tunnel Coal.—This has been worked at Oliver's Slope on the S. side of Bear Ridge. It dips 34° S., and is 5 feet thick. It was tunneled to from Fogarty's Black Mine Slope on West Branch.

It has also been worked at Chillis's Slope by Mr Berry, Superintendent. It is 4½ feet thick, and upon the top there is 8 feet of soft bony stuff. It generally has 2½ or 3 feet of this overlying matter. It dips about 40°. It consists of two benches, the lower being 2 or 2½ feet thick, the upper about the same; and between the two benches is a thin strip of soft dirt; the bottom bench is rather the best coal. It has also been mined by slope-working in Salem Hollow east of Pottsville.

Selkirk or Lawton Coal.—This has been drifted on, but not mined, on Oliver's Bear Ridge Tract. It was found to be irregular, and was thought to be the Spohn Coal.

Rabbit Hole Coal.—At Oliver's Colliery, Bear Ridge Tract, owned by Shippen and Whitaker, and superintended by Mr Headly, the first S. seam opened and worked is the Rabbit Hole. It has been drifted on, and is 3½ feet thick.

In Salem Hollow it is 2½ feet thick, and hard.

Faust Coal.—This has been cut in Berry's and Randolph tunnels.

Salem Coal.—This has been cut in Berry's Tunnel, and also in Randolph Tunnel.

It has been worked at Heilner's Salem Colliery on West-West Branch below Llewellyn.

Mammoth or Daniel Coal.—This has been worked by Adams and Miller at Coal Castle, by George Payne at Heckscherville, and by John Staunton at Glen Carbon. It is from 16 to 20 feet thick, as worked by Lewis Dougherty. It has also been worked by Heilner. At Dougherty's it dips 65° or 70° N., and at Adams and Miller's from 45° to 55° S.

It has been worked at Charles Miller's Slope on Mine Hill at the head of West Norwegian; also at Miller's (?), West Branch Gap, and again under the name of "Back Vein" at the end of the tunnel from Heilner's Slope Vein on Wolf Creek; also in Serril's Lower Tunnel.

It has been worked by Jones and Mason on Mine Hill at the head of East Norwegian. There is a slope upon it. This is the same coal as the Big Coal of Casca William, and the Big North Coal of Silver Creek.

There is a slope upon it at Adams' Pine Knot Colliery, where it has been worked.

It has been drifted upon at M'Ginnis's on Broad Mountain, and worked in Hill's Tunnel on the N. dip of Mine Hill; also by Heilner at West Branch Gap, and by Dougherty at the same locality.

It has been cut in Mecke's Tunnel, and cut and worked in Staunton's Tunnel.

Crosby Coal—probably the Black Valley Coal.—This has been worked at Payne's Colliery, and cut and worked in Staunton's Broad Mountain Tunnel on the S. dip, under the name of the Big South Vein.

In all probability it is the same that is worked at the end of Oliver's Peaked Mountain Tunnel on the N. dip, though some regard it as the Daniel Coal-seam.

SYNONYMS OF THE COALS HAVING MORE THAN ONE NAME IN THE POTTSVILLE BASIN.

Nesquehoning Mines.—The so-called Fifty-feet Coal of the Rhume Run Arch, or saddle of coal, is identical with the so-called Twenty-eight-feet bed of the N. side of the basin of the same locality. This large bed, actually 22 feet thick, probably constitutes the lower portion of the great mass of Summit Hill. The Nineteen-feet Vein is the N. vertical; the Thirty-nine-feet bed is the Brown Vein; and the Twelve-feet bed is the Pencil Vein.

Lehigh Summit Coal.—This enormous stratum of anthracite is in all probability the representative of the chief White-Ash beds of Tamaqua—namely, of Coals B, C, D, Cross-cut, and E, united into one by the thinning-down Eastward of the strata which separate them.

Panther Creek Coals.—The lowest main Red-Ash, or more properly Grey-Ash Seam of Panther Creek, the Eleven-feet bed of Tunnel No. 8, is obviously the Red-Ash Coal F of the Little Schuylkill, and district W. of it. It is the coal of Carter's Slope E. of Greenwood Tunnel.

Tamaqua Coals.—The coal-beds A, B, C, D, D Cross-cut, E and F, the Bony Coal G, the Red-

Ash Vein, and J of the N. side of the Coal-field at Tamaqua, are the coals T, S, R, QQ, Q, P, O, O o, N, and M of the S. side.

Newkirk.—Coal C, or next N. of D in the Newkirk Tunnel, though a strong Red-Ash coal, is the equivalent of Coal C of Tamaqua.

From Tamaqua to Buckville, the coals of the White-Ash Series bear the alphabetical names allotted to them at the former place.

The Bowman Big Vein is supposed to be the Grier.

Tuscarora and Vicinity.—The "Big Vein" of the Palmer Tunnel, and of the same range W., is the Coal E of Tamaqua.

Coal F of Tamaqua is the Palmer Vein, so called, of Tucker's Slope and Palmer Tunnel.

The Tuscarora Coal is the same. F is also the Spade and Luther of Middleton.

The Grier Bed of Tuscarora is Bowman's Big Coal of Newkirk.

Tuscarora to Casca William.—The "Big Vein" of Tuscarora, of Swift's Creek, of Big Creek Mines north of Patterson, of Whitfield's Upper Tunnel, of Casca William White-Ash Mines, and of the flank of Mine Hill north of them, is undoubtedly the Coal E of Tamaqua.

The Black Heath Coal of Casca William is in all probability identical with the Palmer of Tuscarora, or F of Tamaqua.

The Luther Coal of the Red-Ash Colliery of Casca William Valley is the South Diamond Coal of Silver Creek, and the valleys further W. The Adam Stahl of this locality is probably also the South Diamond.

The so-called Palmer bed here is apparently the Peach Mountain Vein.

The Spohn bed of Casca William is a different coal from the genuine Spohn Vein of Norwegian.

Silver Creek.—The Big or North Coal of Silver Creek is unquestionably the same with the Big Coal of the country to the Eastward, or the Coal E of Tamaqua. It bears the name of the "Mammoth Vein" on Mill Creek, and thence Westward to West Branch and Wolf Creek, where it is also called the Daniel Coal.

Dodson's Coal of Silver Creek is the Orchard of Mill Creek.

The Guiterman bed of this valley is on the horizon of one of the lower coals of Tamaqua, but is not at present identified with either of them. It is apparently the Big Coal of Eagle Colliery, Mill Creek, though this is not proved.

The Skidmore Coal of Silver Creek, and the valleys Eastward, is *in position* the equivalent of the Cross-cut bed of Tamaqua, but their continuity has not been established.

The identity of the so-called Big Diamond Coal of Silver Creek and Casca William with the Big Diamond of Mill Creek and East Norwegian is by no means proved.

Zachariah's Run.—The North Diamond is here called the Gin Coal, not the Gin Coal of Silver Creek.

Mill Creek.—The *Big Coal* of Johns' Eagle Colliery is by many colliers of the district believed to be the Mammoth outcropping from the S., but there are good reasons to suspect it to be a lower seam, and identical with the Guiterman bed of Silver Creek.

The *Black Heath Coal* of other localities is here, and on East Norwegian, generally styled the Seven-feet Seam of the Mammoth Bed, which it almost immediately overlies.

The John Holmes bed of Mill Creek is the Black Valley Coal of Silver Creek and other localities.

The Big Diamond of Mill Creek is erroneously called on Lick Run the Big Tracey Coal.

The *Sandrock Coal* of Mill Creek is mined both at Cwmbola and at Belmont under the name of the "Lewis" Coal.

The true Lewis Coal of Mill Creek and the Norwegian valleys bears at Cwmbola and Belmont the title of the *Spohn Vein*, and this erroneous appellation is applied to it on Silver Creek, and still further E. in the basin; the true Spohn is mined by Connor and Roads.

The *South Diamond* of East Norwegian is called on Mill Creek the Green Park Vein, which is the Big Diamond of Mill Creek on another dip.

The Little Sandrock Seam of Mill Creek is the 3d North Gate of the same valley.

On Mill Creek and East Norwegian, the Lewis, Gate, and Tunnel coals are the same bed repeated by the flexure of the Gate Ridge. The small coal above the Lewis at East Norwegian is found above the Main Gate bed on Mill Creek.

The Lower Lewis, or Little Spohn, is the South Gate and the Black Mine Coal.

The Spohn, Palmer, and Yard of Mill Creek Valley, and Chestnut Coal of Singley's Farm, are all identical, and are the same as the Little Perpendicular Gate, or Engine Gate, and are therefore the equivalents of the Selkirk of the S. slope of Gate Ridge.

The Little Tunnel, Rabbit Hole, and Nest coals of Mill Creek are respectively the Yard, Big Sandrock, and Little Sandrock beds of the opposite dip.

THE NORWEGIAN VALLEYS.

East Norwegian.—The Cellar Coal of this valley is the Stevenson of Mill Creek.

Dado's Coal of East Norwegian is the North Diamond of West Norwegian.

The *Clinton* Coal of East Norwegian is said to be the Yard Coal of Mill Creek, and this Yard Coal is the first North Gate bed of Mill Creek, and the Peacock Coal is the Clinton of Mill Creek.

The Peach Mountain Coal of the Norwegian district is the Barclay Coal of the same in the basin South. On Middle Norwegian, the Big Tracey, Chenoweth, and Clarkson, are all identical, being only different outcrops.

In like manner, the Little Tracey and Pearson are the same.

WEST BRANCH AND WOLF CREEK.

Morgan's Coal of West Branch appears to be identical with the Primrose Coal of West Norwegian.

The Mammoth Vein on West Branch is sometimes called the Daniel Coal. The so-called Seven-feet bed of Charles Miller's Slope on Mine Hill (12 feet thick) is the *Black Heath* seam of Heilner's Tunnel.

The *Oak Hill Coals* of West Branch are the *Orchard beds* of West Norwegian. The Spencer is the Kantner bed of Wolf Creek, and both are the Peach Mountain Vein of Norwegian, all identified by actual mining.

The Pelton Coal is probably a portion of the Big Diamond bed of West Norwegian and Mill creeks.

The Big Diamond bed of Wolf Creek, known as Bast's Red-Ash Coal, is not the Big Diamond of Silver and Mill creeks, but is one coal lower in the series, for it underlies the coarse pebbly rock which forms so good a guide to it, whereas the Big Diamond of the valleys E. overlies this conglomerate. The Wolf Creek Big Diamond is therefore an expansion of the small coal which, on Mill Creek, intervenes between the Hancock and Big Diamond beds of that valley. This seam is hardly discernible on Silver Creek, and is therefore a coal of Western development.

WEST-WEST BRANCH.

Upon this valley the lower White-Ash coals of Silver and Mill creeks seem to have greatly thinned down. The Great Mammoth bed with the Black Heath, previously coalesced into one, are either gone or reduced to the 5-feet-thick seam immediately above the conglomerate of Mine Hill; and some of the six or seven still lower beds, proved and partially mined at the West Branch Gap, are here found of notable size. The Black Valley Coal is here called the Forestville Coal. It outcrops high on the S. flank of the mountain, placed there by the ending of axis E. The Black Heath Coal saddles Mine Hill near Woodside.

Bast's White-Ash Coal of West-West Branch is the Anderson Coal; also the Morgan of West Branch, outcropping there in front of Jones' Tunnel, and the Primrose of more Eastern localities. It has been worked through to Wolf Creek.

Kear's White-Ash Coal is the Oak Hill or Little Peach Orchard.

Cockle's Red-Ash Coal is the South Diamond of Silver and Mill creeks, and likewise the Oak Hill of Wolf Creek.

The Phœnix Coal is in the position of the Little Tracey of Norwegian; it is also the Little Diamond of West-West Branch and of Wolf Creek.

On West-West Branch, the there so-called Black Mine and Selkirk coals are the same bed on opposite sides of the folded anticlinal axis of Gate Range.

The Salem Faust and Rabbit Hole beds of this valley at Silvertown Colliery are likewise only one seam, repeated by a subordinate anticlinal flexure.

MINE HILL VALLEY.

At Lawton's Colliery, the Seven-feet Coal over the Lawton or Mammoth bed is the Black Heath Coal; the Eleven-feet seam at Lawton's is the Black Valley Coal.

Fogarty's Big Coal is the Pinkerton Large Seam.

The Adams Slope Coal is the true Daniel's bed, and the coal at the end of the Adams Tunnel is the Jugular Seam. These are again intersected in Payne's Tunnel.

At Oliver's Colliery in the Peaked Mountain, the Back Coal, so called, is the Big South Coal of Staunton's Tunnel, and the Crosby bed of Payne's Tunnel.

MUDDY BRANCH.

The Red-Ash bed of this locality is thought to be Kear's Coal of Forestville.

Whether the coals called the Peach Mountain, Spohn, and Lewis beds near Weaver's, are

actually identical respectively with the coals of these names on Norwegian, is doubtful. The most probable equivalency is that of the Peach Mountain Seam.

Donaldson and further West.—The three large lower coal-beds of this locality, called the Big Vein, the Black Heath Vein, and the Black Valley Vein, are in all probability beds of a Western development, and not equivalents of any main seams of the districts E. Possibly the Black Valley may be represented here, but even this is doubtful, since it is reduced at West-West Branch, distant 8½ miles, to a thickness of only 5 feet. The coal called at Klinger's Gap the *Peacock*, is the *Black Heath* of Donaldson.

The Gardner bed is the better name for the so-called Black Heath of Donaldson. It is impossible, in the existing condition of mining in the Western districts of the Southern coal-field, to identify the many valuable beds of coal there, with known seams of the better-developed central tracts of the basin. There does not prevail that geographical extension of the coals in the Anthracite region, which belongs to those of the great bituminous coal-fields beyond the Alleghany Mountain, nor does either country present them in anything like the continuity very generally imputed to them.

CHAPTER XIV.

SMALL COAL-BASINS OF BROAD MOUNTAIN.

THE next division of the Anthracite Coal-field which claims our attention is the Broad Mountain. A series of parallel anticlinal flexures, most of them of rather gentle curvature, occupy this table-land, and divide it into elevated belts of the Seral conglomerate, and intervening small basins or troughs of the coal strata. Two of these coal-tracts are of sufficient importance to deserve a brief description; one is at the sources of Mill Creek, the other at the very head of the West Branch. These small basins have been only partially developed. That of Mill Creek is in chief part owned by the Boston Colliery Company, who have made some progress in exploring it; while that on West Branch, at the Centre Turnpike, has never been opened, there being no ready outlet for the coal.

Broad Mountain, Mill Creek Basin.—A glance at the general map of the anthracite region will explain the position of this and of the other small basins nearly in a line with it. An important anticlinal axis, the main Southern flexure of the Broad Mountain, after lifting the red shale of Locust Valley, elevates the Seral conglomerate N. of Mine Hill Valley, and passes away Westward into Deep Valley. Where this flexure divides Wolf Creek from the Mill Creek Basin, the dips on both sides of it are very steep. The latter basin is therefore a closely-compressed one, for the S. dips of its N. side are at a very high angle. The whole basin is about 3 miles in length, and at the widest, from conglomerate to conglomerate, about a fourth of a mile broad. Its features are exhibited in the following Section (fig. 189), compiled from observations made at the Boston Colliery, near the middle of the tract.

There would appear to be about three or four beds of coal embraced within the trough, but only the uppermost of these is likely to prove permanently profitable. This coal is one of the thick beds low in the White-Ash series, the equivalent in all probability of the Jugular bed of

Mine Hill Valley. Exploratory shafts sunk upon its outcrop prove it to be about 16 or 17 feet thick, and to be for the most part in a very sound condition, the coal itself being of excellent quality. The dip on both sides of the basin exceeds 70°, but that of the N. side seems at one locality to grow suddenly less at a moderate depth. Between the two outcrops of the great bed the distance is on the average about 600 feet. The quantity of coal here must therefore be very large.

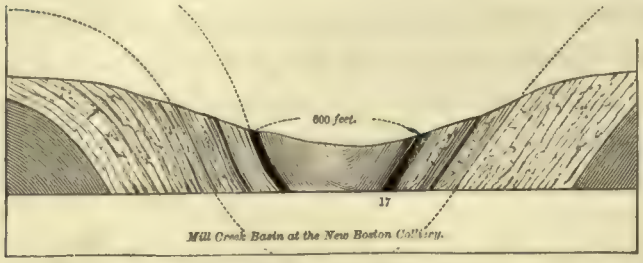


FIG. 189.—Mill Creek Basin, Broad Mountain.

Broad Mountain, West Branch Basin.—Of the coal-beds of the West Branch Broad Mountain Basin but few details have as yet come to light. The accompanying Section (fig. 190) represents its general structure and proportions.

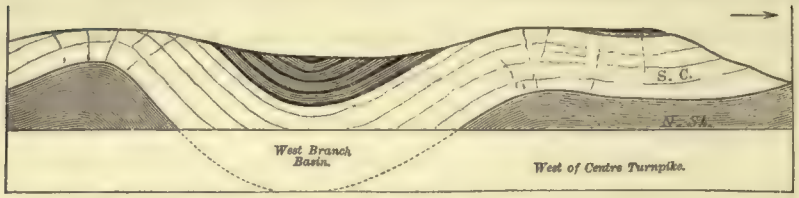


FIG. 190.—West Branch Basin, Broad Mountain.

This little mountain-basin does not promise to be a very productive one.

North of the Mill Creek Basin is an anticlinal having a very gentle N. dip. This includes between it and the greater anticlinal, which ranges along the N. brow of Broad Mountain at the S. side of the Mahanoy Basin, a very small and shallow trough of the Coal-measures, not apparently deep enough to contain any valuable bed of coal. (See Section of Mill Creek Basin, W. of Boston Colliery.)

Broad Mountain, Rattling Run Basin.—The N. edge of the Broad Mountain plateau contains another very shallow limited patch of Coal-measures on the E. side of the deep ravine of Rattling Run, through which the Mine Hill Railroad now descends the mountain towards Ashland. This little basin, if such it deserves to be called, is very nearly in a line with that of New Boston; but the flexures of the central and N. parts of Broad Mountain are too obscure to enable us to connect its shallow troughs. Not more than two seams of coal had been opened in this locality at the date of observation (1853). These belong evidently to the very lowest of the series, and the basin is apparently of too flat a structure to offer much promise of its containing the big seam of the Boston Basin. The latter has escaped denudation solely because of the unusual steepness of the sides of the synclinal flexure.

CHAPTER XV.

GENERAL CLASSIFICATION OF THE COAL-MEASURES OF THE POTTSVILLE BASIN.

IT is not possible, in the present imperfectly-developed state of the Southern Coal-field, to present an exact classification of the coal-formation which occupies it. We know too little of the equivalency of the beds of coal of remote localities, and of the fluctuations of the coal-measures by the thinning-away of some strata, and the introduction of others, to find it

practicable to follow even the most marked planes of subdivision of the series very far. Indeed, a doubt might be raised on philosophical grounds, whether from the nature of the formation any permanent horizons of separation, coextensive with the wide coal-deposit, can exist. Nevertheless, as some general comparison between the stratification of different localities is most desirable, I shall present the best which is practicable with the data I have collected. A summary of the coal-formation, as it appears in the best-explored districts of the coal-field, and the subdivision of the entire series of coal-beds into groups, will furnish the surest elements for co-ordinating one quarter with another.

COAL-MEASURES ON LITTLE SCHUYLKILL.

The total thickness of the true Coal-measures, or the productive portion of the coal-formation on the Little Schuylkill, is about 2000 feet. This mass of strata embraces *seventeen* seams of coal of all dimensions, from 2 to 20 feet. The most natural division of the series in this district is into four groups.

1. A lower White-Ash group, embracing all the coal-beds, four in number, from the lowest to Coal B inclusive. This division of the strata is nearly 700 feet thick.

2. An upper White-Ash group, consisting of four seams; namely, Coals C, D, Cross-cut, and E. This division is nearly 500 feet thick.

3. A Grey-Ash group of two coals; namely, F, and the Bony Vein. This group, counting from the coarse conglomerate above E to the coarse rock overlying the Bony Vein, is 325 feet thick.

4. A Red-Ash group, not subdivisible, of seven seams, commencing with the so-called Red-Ash Vein, and including the uppermost coals in the basin. This fourth division has a thickness of nearly 500 feet.

Summing together the thicknesses of these coal-beds intersected by the Little Schuylkill, and counting, not the pure merchantable coal, but everything between roof and floor, their total depth in this part of the coal-field is 120 feet, or precisely 6 feet of coal, on an average, for every 100 feet of rocks. We may abate at least one-third from this, for material not suitable for the coal-market.

COAL-MEASURES ON SILVER CREEK.

The great natural transverse section of the strata, furnished by Silver Creek, allows us to estimate the whole series pretty accurately as high as the Peach Mountain seam, but above this, from the synclinal axis to the Schuyl-

FIG. 191.—Coal Strata at the Little Schuylkill.

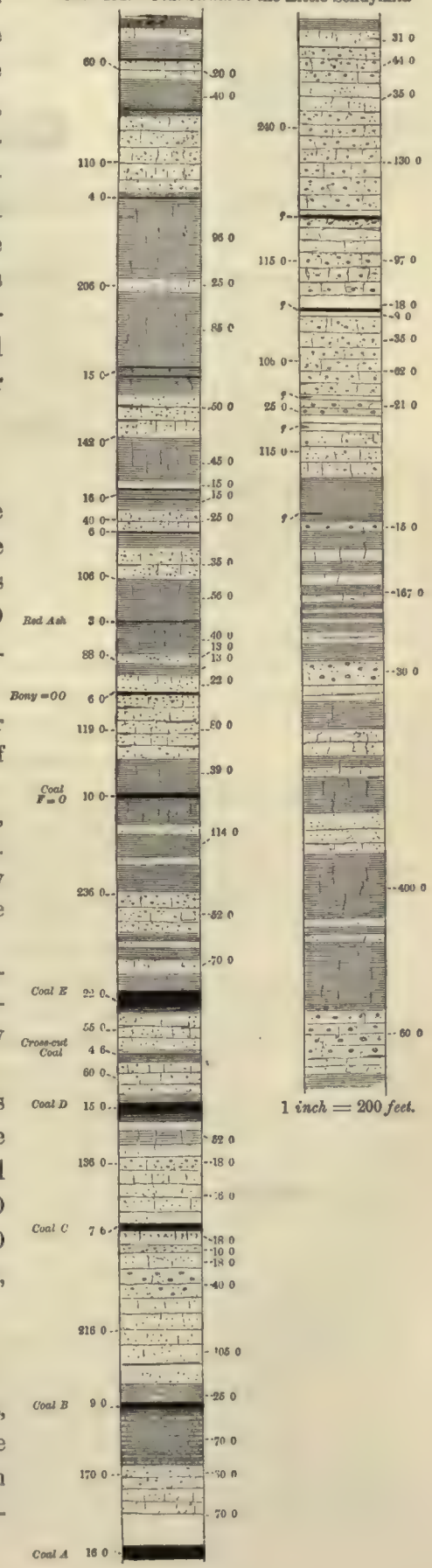
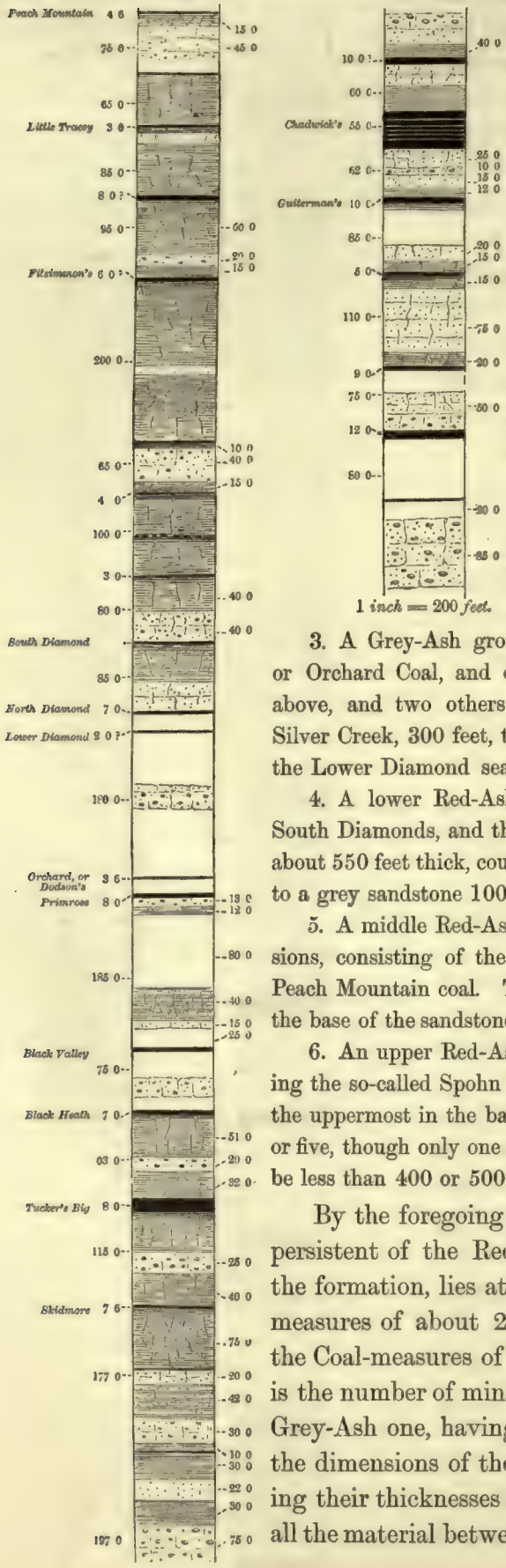


Fig. 192.—Coal Strata on Silver Creek.



kill Valley, the exposures are defective. Between the coarse conglomerate underlying all the coals, and the uppermost strata, S. of the Schuylkill, the total depth of strata is not less than 3000 feet. Within this mass we can identify *twenty-six* or *twenty-seven* notable coal-beds, two of which are of great dimensions. In this district the coals are separable into six groups, as follows :—

1. A lower White-Ash group, composed of seven seams, all of them, but the lowest and the fourth, being 9 feet and upwards in thickness : measuring this division from the top of the coarse underlying conglomerate to the bottom of the Egg and Nut-conglomerate, which overlies the Ten-feet-thick Coal over Guiterman's Great Bed, its thickness is about 600 feet.

2. An upper White-Ash group, embracing five beds of coal, the middle one being the Big North Coal, or Tucker's Seam, 18 feet thick, and the highest the Black Valley bed. The division of the strata embracing these coals has a thickness of 700 feet.

3. A Grey-Ash group, comprising, on Silver Creek, the Primrose and Dodson's, or Orchard Coal, and on Mill Creek the same, with the addition of the Hancock above, and two others beneath. The strata, including this group, measure, on Silver Creek, 300 feet, the upper limit being the base of a coarse conglomerate under the Lower Diamond seam.

4. A lower Red-Ash group, composed of six coal-beds, the Lower, North, and South Diamonds, and three coals above them ; these are embraced in a mass of strata about 550 feet thick, counting from the conglomerate underneath the Lower Diamond, to a grey sandstone 100 feet and more below the Fitzimmon Coal.

5. A middle Red-Ash group of five coals, all but the fourth of workable dimensions, consisting of the Fitzimmon, Big Tracey, Little Tracey, a thin coal, and the Peach Mountain coal. The depth of coal-strata embracing this group, bounding it by the base of the sandstone next over the Peach Mountain Vein, is also about 550 feet.

6. An upper Red-Ash group, embracing all the obscurely-developed beds, including the so-called Spohn Vein, overlying the Peach Mountain seam, and extending to the uppermost in the basin. The number of coal-seams here embraced may be four or five, though only one or two are known. The total thickness of the strata cannot be less than 400 or 500 feet.

By the foregoing estimate, the Peach Mountain bed, one of the most persistent of the Red-Ash seams, and therefore a good landmark within the formation, lies at a height above the conglomerate base of the Coal-measures of about 2700 feet. A survey of the entire series shows that the Coal-measures of Silver Creek are exceedingly rich in coal. Not only is the number of minable beds unusually large—each group, excepting the Grey-Ash one, having more than its average quota of such seams—but the dimensions of the coals themselves exceed the normal size. Estimating their thicknesses in the gross—that is, by the usual mode of counting, all the material between the roof and floor, namely coal, bone coal, and slate,

as belonging to the coal-seam,—the aggregate amount of coal in the basin reaches the unusual quantity of 207 feet, or very nearly seven feet of coal per hundred feet of strata.

FIG. 193.—Coal Strata on Mill Creek.—1 *inch* = 200 *feet.*

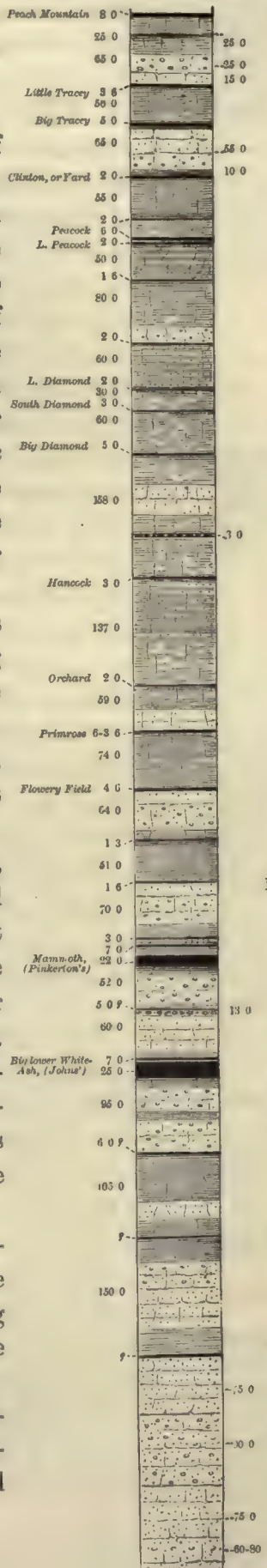


FIG. 194.—Coal Strata in the gorge of Mill Creek, opposite Wolf Creek (for comparison).—1 *inch* = 200 *feet.*

COAL-MEASURES ON MILL CREEK.

Mill Creek affords us almost as complete a section of the whole coal-formation as is furnished by Silver Creek. Though somewhat more obscure in the Peach Mountain belt, it is far more complete in the Gate Range, and in the South-dipping coal-seams of the N. side of the Sharp Mountain basin. In this district the total thickness of the productive part of the formation, counting from the upper limit of the barren conglomerate to the synclinal axis at the Schuylkill River, would appear to be, from our careful measurements, nearly 2700 feet, embracing *thirty-six* separate beds. This body of strata is divisible into the same six natural groups which it exhibits on Silver Creek, the corresponding groups differing materially, however, in their subdivisions or details; they are as follows:—

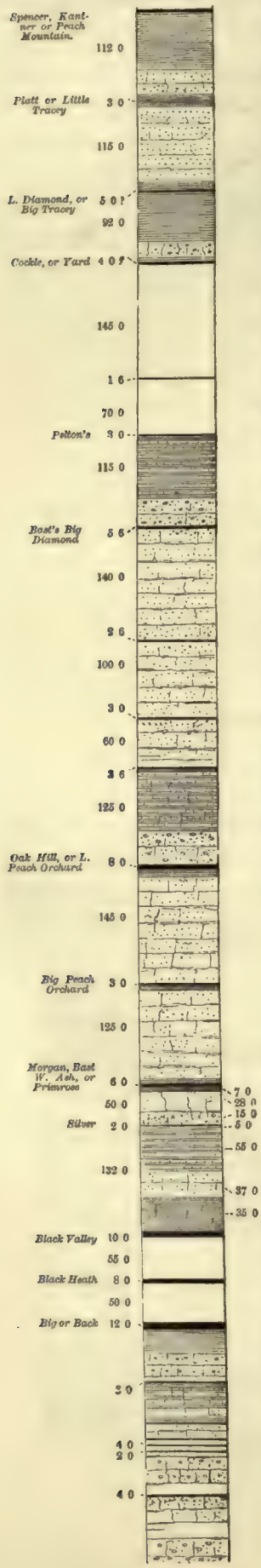
1. A lower White-Ash group, comprising five seams of coal of workable dimensions, the fourth ascending being the Great Bed of Johns' Colliery, sometimes called the Jugular Vein, the average thickness of which is 25 feet. Between the underlying conglomerate and the sandstone, above the 7-feet-thick rider of the Jugular, the thickness of strata, including these five coals, is about 500 feet.

2. An upper White-Ash group of six coals, containing, as its second seam ascending, the Great Mammoth Coal or Pinkerton's Bed, 22 feet thick. Placing the upper limit of the strata enclosing these coals at the base of the coarse pebbly sandstone which underlies the Flowery Field, or Holmes' Coal, the thickness of the division is 310 feet. The two uppermost seams are thin; the others are of workable dimensions. This group, as usual, contains some valuable nodular iron-ore, especially in the fireclay floor of its lowest coal-bed, and in the shale which overlies the Mammoth Vein.

3. A thick Grey-Ash group, including four coal-beds—the Flowery Field, the Primrose, the Orchard, and the Hancock seams. This part of the Coal-measures, making its upper limit the base of the thick sandstone beneath the Big Diamond, is about 430 feet thick.

4. A lower Red-Ash group, comprising eight Coal-beds, only two of which, the Big Diamond and the Peacock, are of a good thickness, the rest being 3 feet and

FIG. 195.—Coal Strata on West Branch and Wolf Creek.



under. They are, in ascending order, the Big, South, and Little Diamonds, then two unnamed thin coals, then the Little Peacock, Main Peacock, and a thin coal, the next beneath the Clinton or Yard Seam: all these are embraced within 435 feet of strata.

5. A middle Red-Ash group of five coals, the Clinton or Yard, Big Tracey, Little Tracey, Lower Peach Mountain, and Main Peach Mountain Beds; the Big Tracey and Peach Mountain Seams being those of principal value for mining: these all lie included within less than 300 feet of rocks.

6. An upper Red-Ash group, of less definable thickness. Assuming the Tunnel Seam of the Schuylkill Basin as identical with the Peach Mountain Vein, this uppermost group includes the Little Tunnel, the Rabbit Hole, the Nest, the Faust, the North Salem, Weasel, Main Salem, and South Salem Beds, in total number eight. The total thickness of this group, extending it to the highest rock in the coal-field, at the synclinal axis under the river, is about 700 feet.

It will be seen, upon reviewing the Mill Creek Coal-measures in comparison with those of Silver Creek, that while the lower White-Ash group is thinner by 100 feet, the upper White-Ash group is thinner by nearly 400 feet, or is reduced to less than one-half its thickness; on the other hand, the Grey-Ash measures have considerably augmented in thickness. Again, both the lower and middle Red-Ash measures are of considerably less bulk, the middle having scarcely more than half the depth they possess on Silver Creek. On Mill Creek the interval between the barren conglomerate and the Peach Mountain Coal is not quite 2000 feet. The total thickness of coal, by the ordinary method of estimation, is, at this section of the basin, about 155 feet, an average of 5 feet 9 inches for each 100 feet of strata.

COAL-MEASURES ON WEST BRANCH AND WOLF CREEK.

At the natural transverse section of the Coal-measures presented by the Valley of the West Branch and its tributary Wolf Creek, it is practicable to deduce, from the exposures of the strata, their total thickness with a fair approximation to accuracy.

Our carefully-conducted measurements make it appear, that between the top of the unproductive conglomerate and the highest strata in the synclinal axis at Westwood, the depth of the Coal-measures is not less than 2800 feet. A comparison of this section with that of Mill Creek and those of the districts still further E., shows, however, that, group for group, the Coal-measures of this part of the basin differ materially from those already reviewed. The entire series, containing about *thirty* beds of coal, may, for convenience, be divided as hitherto into six groups —two of White-Ash, one of Grey-Ash, and three of Red-Ash seams: their respective contents and dimensions are as follow:—

1. The lower Red-Ash group embraces on West Branch five beds of coal, counting from the conglomerate to the Skidmore inclusive. The largest of these is only 4 feet thick, and, what is quite as remarkable, they are all embraced within less than 200 feet of strata. So attenuated a condition of the group contrasts remarkably with its thickness and its repleteness in coal, on Silver Creek, and even on Mill Creek.

2. The upper White-Ash group, as seen on West Branch, consists as usual of four seams, a 3-feet thick bed, the equivalent of the true Skidmore, and the Mammoth, Black Heath, and Black Valley; the two first of these still thick, and closely approximated. Adopting for the limits of these strata the sandstones which insulate them from the other groups, the whole thickness is not more than 250 feet. Here again we have a nearer approximation to the state of things on Mill Creek, where, as we have seen, this group measures about 310 feet.

3. The Grey-Ash group consists here of three coal-beds—the Silver Vein, which is thin, and the Primrose or Bast's White-Ash, 6 feet thick, and the Big Peach Orchard, only 3 feet thick. Counting from the top of the underlying sandstone to the top of the overlying, the Coal-measures, chiefly sandstones, embracing these coals, show a thickness of 350 feet, a depth considerably less than that which they exhibit on Mill Creek, where, however, the Hancock Bed, the probable equivalent of the Little Peach Orchard, or Oak Hill of this Section, is included in the group. If it be embraced here, the Grey-Ash group, containing, however, a Red-Ash coal, will have a thickness of 450 feet, or that which it possesses on Mill Creek.

4. The lower Red-Ash group proper, extending it to include the Oak Hill bed as its lowest, and a small coal above Pelton's Vein as its highest, comprehends on Wolf Creek seven distinct seams, or one more than it embraces on Mill Creek, due probably to the absence, or possibly the non-discovery, of a thin bed beneath the Cockle Coal. These seven known lower Red-Ash seams are embraced in 775 feet of strata, exceeding by more than 300 feet the thickness of the corresponding division on Mill Creek.

5. The middle Red-Ash group embraces on West Branch and Wolf Creek apparently the same four coals which characterise it on East Norwegian and Mill Creek—that is to say, the Cockle, Clinton, or Yard; the Big Tracey, here called the Little Diamond; the Little Tracey, here called the Platt; and the Peach Mountain, here called the Spencer or Kantner. The division of the formation to which these coals pertain measures about 400 feet, an expansion of 100 feet beyond its thickness on Mill Creek.

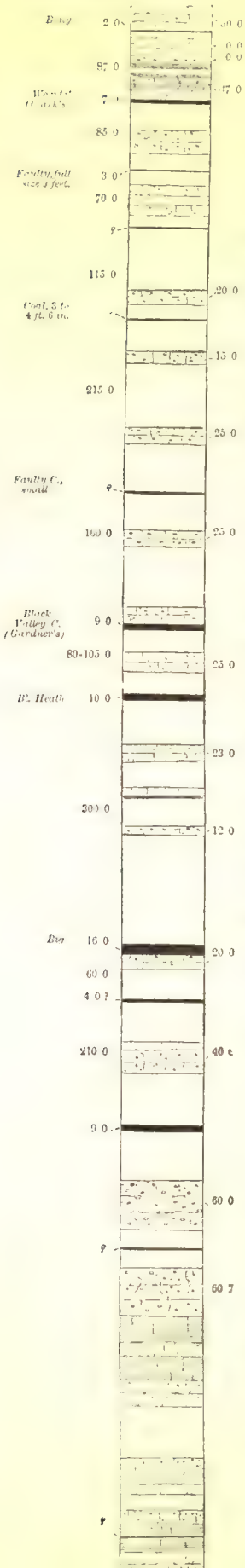
6. The upper Red-Ash group of West Branch is not susceptible of quite so accurate an estimate of the number of its coals and of its thickness, as the groups beneath it. Assuming the Black Mine Coal of Fogarty's Slope Mine to be the true Black Mine of Pottsville, and the Tunnel Coal above it to be the true Peach Mountain bed on its most S. dip, the coals of the upper group of this valley hitherto developed, are five in number, though it is probable, from the size of the vacant spaces, that the whole list is not less than seven; these are embraced in 700 or 800 feet of strata.

By summing together the average thicknesses of all the coal-beds in this district, I find the total depth of coal to be 121 feet, which in 2800 feet of rocks shows a thickness of 4 feet 4 inches of coal-seam to each 100 feet of strata.

COAL-MEASURES IN THE THICK MOUNTAIN NORTH OF DONALDSON.

It is not possible to estimate the total thickness of the Coal-measures preserved in the coal-field of the Donaldson Basin; nor, indeed, with any accuracy in either of the W. branches of the

Fig. 196.—Coal Strata in the Thick Mountain at Donaldson.—1 *inch* = 200 *feet*.



main valley. We can do little more at present than indicate the remarkable change of type which the several groups of the series have undergone, in their passage from the Middle and Eastern districts of the basin to the valley of Good Spring Creek. It is not even practicable, as far W. as Donaldson, to recognise with any certainty more than a few of the groups so well discerned further E.

1. The lower White-Ash group is almost entirely obsolete, being represented by two or three very thin and impure layers of coal, outcropping among the sandstones high on the table-land of the Thick Mountain. The Section illustrating the strata on West-West Branch, shows that even there this lowest group is reduced to nearly the same attenuated condition.

2. The upper White-Ash group is richer apparently in coal than it is at West-West Branch. It embraces at Donaldson the three lowest workable seams; a bed reputed to be 9 or 10 feet thick; a thinner coal, supposed to be 4 feet, but faulty; and the so-called Big Coal, estimated at 16 feet. Counting the encompassing strata, this division of the measures embraces nearly 400 feet. The so-called Big Coal is the continuation of the Forestville seam or Black Valley bed of more E. localities, and is therefore on the confines of the White and Grey-Ash groups; indeed, one bench of it is stated to yield a grey or pinkish ash. The Black Heath Coal of Donaldson is on the horizon, therefore, of the Anderson of West-West Branch, or true Primrose, if this elsewhere persistent bed extends so far W. So again the Black Valley seam of Donaldson is the equivalent of the Orchard. Both of these are, therefore, representatives of the Grey-Ash group, unless, indeed, that group is gone, in which case they correspond to the bottom coals of the whole Red-Ash series. It would be idle to attempt to co-ordinate the remaining coals of the Donaldson Section with the several Red-Ash groups of other districts, for not one of them has been traced by mining, or even shafting, into any recognised Red-Ash coal of either Muddy Creek or West-West Branch.

RELATION OF THE COAL-BEDS OF MINE HILL VALLEY TO THE WHITE ASH GROUPS OF THE MAIN POTTSVILLE BASIN.

A comparison of the strata at the E. end of the Mine Hill Basin, and at the gorge of Mill Creek opposite the mouth of Wolf Creek, with the lower Coal-measures S. of Mine Hill, demonstrates, as our Mill Creek Section and the vertical columns will show, that the Big Coal of Lawton's Old Colliery, and of Montelius's Open Cut fronting Wolf Creek, is the equivalent of Johns' Great Seam, and *not* of the Mammoth bed situated S. of it. It is, in other words, the Jugular Coal of the Mine Hill Basin, the Daniel Seam of the more W. collieries in the basin, being the true Mammoth. The absence of the Jugular bed at the W. localities on the S. side of Mine Hill, or rather its great reduction in size at Mine Hill Gap and elsewhere, is perfectly in accordance with the law of its steady and rapid diminution to

the W. or S.W. all the way from Silver Creek, where its bulk is at the maximum ; indeed, this diminution extends, with but one or two exceptions, to all the coals of both the lower and upper White-Ash groups, applying almost as strikingly to the Mammoth seam as to the Jugular itself.

A study and comparison of the several columnar Sections introduced into this chapter, will enable the reader, with very little trouble, to verify the above descriptions of the various groups of coals under the several phases they assume, and to learn the extent and the special nature of their many and curious changes.

From this description of the structure of the central belts of the coal-field, it is obvious that the anticlinals there met with are not of magnitude sufficient to lift to the surface a great thickness of the Coal-measures ; the small number of the North-dipping coal-seams, or the narrowness of these anticlinal belts, being a convincing proof that the flexures are of minor extent, compared with the depth of the whole coal-formation. They are, in fact, but folds or local *plaits* in the general mass of the South-dipping strata, which slope away with a moderate inclination from the elevated Mine Hill anticlinal towards the bottom of the S. trough at the N. foot of the Gate Ridge, or the deeper one at the base of the Sharp Mountain. It must follow from this fact, that between the crest of Mine Hill (where alone the conglomerate floor of the whole coal series is lifted to the surface) and the uppermost strata of the S. basins, there exists an enormous thickness of the coal-bearing rocks, and a correspondingly large number of separate seams of coal. The precise aggregate thickness of the Coal-measures, and the exact number of distinct beds of coal rejecting their repetitions, are questions remaining in some doubt, for it is not practicable at the present time to determine for this part of the coal-field the true place and identity of every bed ; nor do we know what allowance to make for reductions of thickness from compression and slipping. Yet I have been enabled to offer, in the preceding chapter, an approximate determination, which may not be without its interest and utility to the reader, and to the explorer of the region. If we assume the total thickness of the Coal-measures, between the top of the conglomerate of Mine Hill and the highest Red-Ash coal at the Schuylkill, to amount to about 3000 feet, we shall not be very far from the truth ; nor shall we commit an error of more than one or two beds, *if we assign twenty-five as the total number of coal-beds of workable dimensions.* To these there must be added nearly an equal number of thin seams and bands of coal, generally neglected on account of their unprofitable size. This estimate will make the whole number of separate beds of anthracite preserved from denudation not much short of *fifty.*

It must be apparent from the foregoing evidence of the dimensions of the Coal-measures, and the number of the coal-beds, that the bold assertion often indulged in that the Big White-Ash bed lies at the easily accessible depth of a few hundred feet in the middle and southern parts of the coal-field, is absurdly erroneous. Nothing but gross ignorance could have prompted to the costly borings undertaken to reach the White-Ash coal on East Norwegian, and at the anticlinal axis of the Gate Ridge, near Pottsville.

CHAPTER XVI.

FAULTS AND SLIPS OF THE STRATA.

IMPORTANT effects have been produced upon all the inverted coal-seams to the S. of the synclinal axis of the Sharp Mountain Basin by the excessive pressure exerted upon them at the time they were elevated and inverted. Throughout nearly the whole extent of the Sharp Mountain the coal-seams and the softer argillaceous beds bear the marks of their having suffered a movement in the direction parallel with the plane of stratification, analogous to the sliding which takes place between the adjacent leaves of a ream of paper when one side only is lifted. In some of the seams nearly the whole body of the coal itself has been crushed into fragments, and the bounding surfaces of these are brightly polished by the mutual rubbing they have undergone, and one bed of the Sharp Mountain, called hence the Plumbago Seam, has nearly all of it been converted into small lenticular flakes, of a lustre and colour somewhat resembling black-lead. Another effect of this slipping of the coal upon itself is a warped or twisted folding of the coal-seams, and their alternate contraction and enlargement by undulations in their confining strata. Thus the levels in some of the gangways have a decidedly serpentine course, and similar undulations of roof and floor are visible in the direction of the dip. It must be apparent from this statement, that the coal-beds of the Sharp Mountain can in very few instances repay the miner the cost of entering and working them, and experience has already amply demonstrated their general unfitness for mining.

Tunnels several hundred feet in length have been driven through these coarse silicious strata to get access to the thick White-Ash coal-beds near the bottom of the series, but in every instance the coal, when reached, has been so excessively crushed as to prove unprofitable.

In the following generalised Section (fig. 197) of the Sharp Mountain, an attempt is made to show the character of the crush which the strata have undergone.

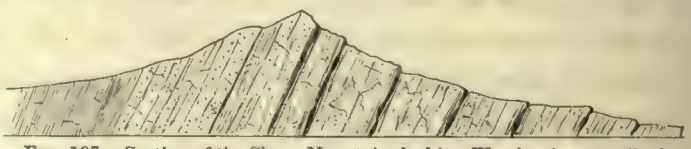


FIG. 197.—Section of the Sharp Mountain, looking W., showing overtilted strata and crushed coal-seams.

An important class of disturbances producing faults and slips of the strata are the steep anticlinal flexures. The most conspicuous of these in the Southern basin is the anticlinal wave of Mine Hill. The position and longitudinal extent of this axis are shown upon the Map, and have been already spoken of; but the present is the proper place in which to explain the special influence of this uplift in its effects upon the Coal-measures which dip away from it. It is a beautiful example of that form of anticlinal which I have denominated, in my general Chapter on Structure, the *normal flexure*, displaying a gentle inclination of the strata upon its S. side not exceeding 20°, and a dip as steep as 60° or more on its N. It is therefore an oblique arch, and the axis-plane, or that which bisects the curve, is not perpendicular, but dips steeply to the S. From this attitude of the strata in the ridge, and also from the far greater denudation which its N. flank has suffered compared with its S., under the floods which have poured Southward against it from off the long slope of the Broad Mountain, the Coal-measures of the S. slope of Mine Hill rise to a much greater height upon its side than those of its N. The lower coal-beds of the series are extremely valuable, both on account of their dimensions and their excellent quality,

and on the S. side these occupy a position extremely favourable to their being extensively and successfully wrought; and they have, therefore, become the site of some of the most important collieries of the district. But upon the opposite or N. side of the ridge, the crest of which exposes the Seral conglomerate, the coal-rocks ascend the slope too short a distance to present any useful amount of breast above the water-level. This arises in part from their having, as already stated, been more washed away, and in part from their presenting steeper dips.

There is a very different amount of N. dip in the two sides of the Mill Creek Gap: for on the W. side the inclination is 60°, on the E. it is 80°. There has therefore happened at this point a transverse or N. and S. dislocation, arising from a horizontal as well as an upward pressure.

Similar cross-fractures are discernible in a difference of dip in the opposite valleys of many of our mountain-gaps, as at the Delaware Water-gap; and they will be found to be in very many instances connected with the leading anticlinals, or more frequently still with great *dislocated anticlinals*, which ar ethe principal longitudinal faults of the country.

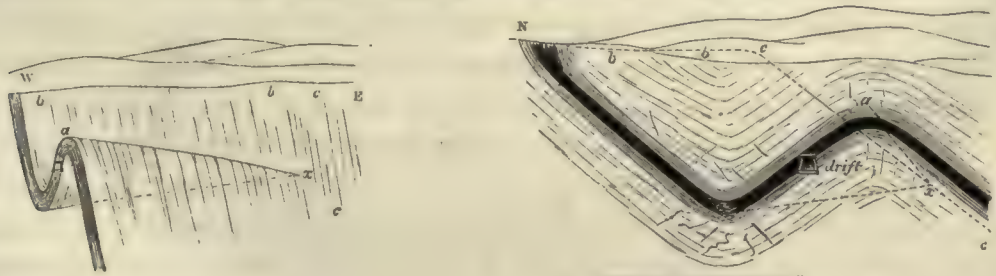
An important feature of the Pottsville Basin, well deserving to be noticed, is the more undulated character of the strata in its S. and central portions. There the anticlinal flexures display a strikingly greater inclination of their N. over their S. branches. They possess, in other words, the characteristic oblique form. Throughout the greater part of the district usually three such well-marked anticlinals occupy the middle portion of the valley, while other contortions of less length are variously interposed among them.

It is a matter of very general observation, that whenever the North-dipping coal-beds are very highly inclined or perpendicular, as they very frequently are, they are more or less crushed and irregular, and of no lasting profit to the collier; and it is, moreover, well known that they are of comparatively shallow depth, turning up into the next adjacent South-dipping seams on their North, to form, with these, narrow and local oblique basins. These features are exemplified in the Lewis and Spohn veins of Middle Norwegian, where an anticlinal N. of the main regularly South-dipping Lewis Vein is connected with a very steeply inclined North-dipping coal, which is faulty and crushed, and which at no great depth unites with the so-called Spohn Vein, which, dipping Southward towards it, forms with it a small synclinal trough.

Contortions, Faults, and Troubles.—Of the *lesser contortions* and irregularities in the strata, the instances in this district are almost innumerable. These local disturbances, frequent as they are, will be found, upon investigation, to group themselves into a few classes, in each of which the nature of the displacement is easily analysed.

A common form of irregularity in the coal-beds consists of a local fold or *rumple.* This is of the nature of a real axis or small flexure in the strata; and when such is the case, the fold will very frequently be found, when traced in the direction of the strike or upon a level, to smooth

Fig. 198.—Flexure in Red Mountain Coal-bed, Lorberry Creek.



a, Anticlinal axis, drooping away at X.
b b, Crop continued Eastward to the regular S. dip c c.
From a to X 400 feet.

itself out and disappear in the general dip. An illustration of this irregularity is here given (fig. 198), taken from the Red Mountain coal-bed on Lorberry Creek in the Swatara district.

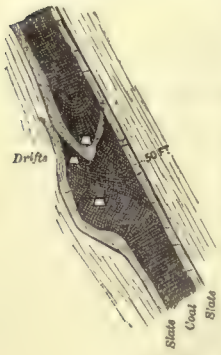
Contortions of the coal-beds unaccompanied by fracture are very numerous in some portions of the coal-field. Where the flexure reaches its maximum degree, the short leg of the anticlinal becomes of course inverted, and then the coal in all this part of the bed, and at both the anticlinal and the synclinal elbows, is in a compressed and fragmentary state. There are other irregularities of the coal arising from a sudden change of inclination, once or oftener, within a small space. Such usually announce proximity to a crushed axis, or, what is the same thing, to a longitudinal dislocation, which is but the extreme limit of the displacement that, towards its termination, closes and becomes a mere fold or axis.

The actual displacements or breaches of contact in the coal may be divided into two classes; one embraces every form of disturbance in the coal-bed parallel to its dip, the other every variety of cross fracture. The first might for convenience be called *parallel slips*, the others are named by their usual title of *faults* or *cross fractures*.

In very many instances the parallel slips present an extensive disturbance of the mass of the coal-bed within itself, without more displacement of the roof and floor than amounts to a series of local bulgings and contractions of the layer. The coal has rubbed upon itself, and is in a more or less fragmentary, friable, and polished state. To admit of this parallel displacement or moving forward of one part of the bed upon the other, there must have arisen somewhere, it is obvious, either a fracture or a doubling upon itself of the roof or the floor, or of both. It has been already shown that the Sharp Mountain beds illustrate to an extraordinary degree this form of displacement by parallel slipping.

Not infrequently the miner comes upon fractures in the roof or the floor of his coal-bed, which explain to him the origin of local parallel dips. In these cases, the one boundary of the bed giving way, and not the other, the forward movement of the coal causes one of the broken portions of the roof or floor to pass by or overlap the other, and even to bend and curl up under the prodigious pressure applied to it. This is exemplified in the accompanying Section of a disturbance of this nature in the great bed of Lorberry Creek, where the floor has broken, become involved in the sliding coal, and curved back upon itself until it has met the roof. At this point the bed, the proper thickness of which is about 27 feet, has been swollen by the overlapping of its splintered ends to a size of 50 feet.

Fig. 199.—Section of a Swell in the Big Coal of Lorberry Creek, Pinegrove.



Of the other class of displacements, the cross fractures or true faults, little need be said here in detail. Where they range with the strike or course of the strata, they will be found to terminate generally in anticlinal folds or flexures, first closely compressed and crushed, but farther on becoming more regular, and at last dying out into the general dip. Such longitudinal faults bring a rock-wall against the lower end of the coal-bed, and in each instance where a valuable vein is thus abruptly cut off, it becomes a problem of much practical interest to determine the *direction* in which the lost portion of the coal-bed is to be sought.

It may be accepted as a *general rule*, not without its occasional exceptions, that these longitudinal faults consist of an *upthrow of the vein to the S.* of the fault, so that the remainder of the vein, if we are mining downward, will be recovered at a point above, and further back

towards the outcrop, compared with the spot where the rock-wall crosses the mine. Tracing such a fault through its successive stages, we shall generally be able to resolve it into a *broken* oblique flexure, and then into a gentle normal one. The three conditions of the dislocated flexure are illustrated in the diagrams here annexed.

Another species of cross fracture or dislocation is where the break is *transverse* to the strike or course of the strata, sometimes perpendicular to it, sometimes oblique. These displacements bring a rock-wall abruptly against the vein in the direction of its length, or, in other words, at the end of a gangway or level; and only when they are oblique do we encounter them also in the direction of the dip. When traced for any considerable distance across the strata, such a fault will be found to be connected with a difference in the slope of the beds upon its two sides, the one portion having been more uplifted than the other, and therefore shoved forward beyond it. Allusion has been already made to an instance of this sort on a striking scale in the N. side of

Fig. 200.—Successive Phases of a Dislocated Flexure.

Mine Hill, at the passage of Mill Creek. Another example is to be seen in the gap at the Panther Head, near Pinegrove; and within the mines in the Pottsville district many more such cases, though generally upon a lesser scale, are to be met with. These are all to be explained by some inequality in the transverse pressure, propagated Northward or Southward to the dislocated strata; and this inequality will usually be found to proceed either from the sudden rising of an anticlinal flexure to the N. or S. of the position of the fracture, or from the sudden termination of a longitudinal dislocation. Where an *obliquely* transverse fault divides the strata, we shall usually discover that the most uplifted set of rocks has been shifted forward beyond the termination of the other less inclined portion.

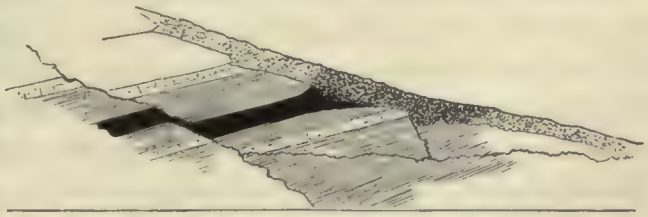


Fig. 201.—Cross Fractures displacing a Coal-seam.

Besides the foregoing varieties of transverse displacement, the collier encounters innumerable cases of lesser degrees of fracture and crush disturbing the regularity of his coal-beds. Sometimes the fault amounts to only a trivial heave of the bed, leaving a thin leader to guide him to the displaced portion. The shivered condition of the strata attending such irregularities is sketched in the little Section here annexed (fig. 201).

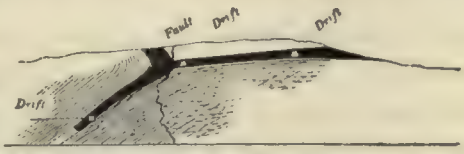


Fig. 202.—Dislocation causing a Double Outcrop at Peach Mountain Seam near Minersville.

Another less common form is shown in the following sketch (fig. 202), which represents a curious disturbance in the Peach Mountain coal-bed near Minersville, where the transverse pressure, besides breaking the strata, has bent up the end of the coal-bed into a perpendicular position past the remaining fragment of

the seam, which has been left nearly flat. There have thus been formed two separate outcrops. A similar fault occurs in the Peach Mountain Coal on Silver Creek.

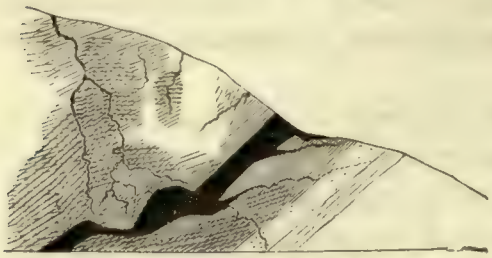


Fig. 203.—Section of "a Trouble" in a coal-seam.

An irregularity much more frequently met with than either of the foregoing, is that crushed and disordered condition of the coal-bed, which properly deserves the name of a *trouble*. It usually accompanies a somewhat shattered condition of the adjoining strata, where there has been a partial transverse movement, not amounting to a distinct cross-fracture or fault. It is a displacement of the coal in directions intermediate between the strictly transverse and the parallel, and therefore partakes of the features of the true fault and the slide. A common form of these troubles is shown in the diagram (fig. 203).

It is of the greatest importance in mining that the collier should make himself familiar with the derangements of the strata in his particular district and neighbourhood, so as to determine for himself, if possible, the prevailing character and direction of the displacements. An intimate acquaintance with the underground workings in the adjoining mines, will very frequently show him that these follow a certain rule or law, and it will teach him to infer, from the presence of peculiar signs of irregularity, not only the nature of any fault or derangement which he may be approaching, but the readiest means for either avoiding or passing through it. It is greatly to be regretted that a sound acquaintance with geological principles, especially those laws of structure which furnish so admirable a key to the complexities of our Appalachian Chain, is not more generally diffused among the colliers, mining engineers, and others, who have the conducting of our now extensive mining operations in Pennsylvania. Every well-wisher to the S. Commonwealth, the interests of which are becoming more and more bound up with the prosperity of her mines, must earnestly desire the education of her mining population, out of whose intelligence and invention alone can arise the wisest economical applications of the great mass of capital which her coal-fields are soon to absorb. I cannot close this present discussion of the derangements of the coal strata, which so frequently baffle the perseverance and waste the resources of our miners, without pressing upon the attention of all interested in our collieries the vast importance of some organised plan for the construction and preservation of a regular series of *mining records*, through which full information may be gained at any time of both the present and the past situation of all the important workings. Already vast underground tracts have been wrought out, and should no permanent registration be made for the guidance of future operators, time will inevitably efface the recollection of essential details, until it will be impossible to ascertain, except through fallacious traditions, the real boundaries of the coal, and especially the nature of the faults which so frequently suspend for a lapse of years the prosecution of certain mines. In this uncertainty, frequent misapplications of enterprise, a large waste of capital, extensive damage to property, and even serious loss of life, must inevitably be incurred, and with a yearly increasing liability, as the old workings become more numerous. England, ever watchful of her industrial interests, and awakened to the long-neglected importance of this subject, has secured the future prosperity of her vast mines by establishing, on a scale of great liberality, an office for the preservation of such mining records of every description. Let Pennsylvania think of her own future necessities, and profit, while there is yet time, by the valuable lesson which the exigencies of the mining art have taught the Government of Great Britain.

DIVISION II.

EASTERN MIDDLE ANTHRACITE COAL-FIELD.

CHAPTER I.

GENERAL STRUCTURE AND TOPOGRAPHY.

THE Eastern Middle Anthracite coal-field of Pennsylvania is bounded on the S. by the Red-shale valleys of the Quakake and the upper Catawissa, on the N. by that of the Nescopec, on the E. by that of the Lehigh, and on the W. by the branches of the valley of the Catawissa. It comprises a high rolling table-land, of a maximum elevation above the level of the sea of a little less than 2000 feet. It is penetrated from the E. and W. by two sets of main anticlinal undulations, some of the longer of which pass each other in the more central portions of the plateau, while others almost unite to form continuous anticlinals through it. By a law of structure prevalent in many districts of the Appalachian Chain, where the upper rocks left by denudation are firm and resisting ones, and the strata beneath them readily eroded, these anticlinals invariably enter the coal-field by deeply denuded valleys or coves, the mountain-spurs enclosed between them being habitually of synclinal structure. Viewed in another aspect, the main basins of the district, traced E. and W., throwing off the form of valleys, run out into high insulated synclinal mountain-spurs; while the anticlinal ridges leave the table-land under opposite features, passing from the configuration of long narrow ridges, separating the basins into the hollows or coves which, in both directions, make down into the Red-shale valleys of the exterior country.

Viewing the flexures of this complicated coal-field in a large way, the whole district naturally divides itself into six leading synclinal belts, separated by five general anticlinal ranges, both the synclinal and the anticlinal tracts consisting rather of chains of basins and saddles, than of simple continuous flexures. Before proceeding to a detailed description of the individual lesser saddles, and the basins of coal embraced between them, it will be expedient to indicate these larger features, and to classify the great anticlinal belts, and the general coal-basins which they separate.

ANTICLINAL BELT No. 1, OR THAT OF PISMIRE RIDGE.

The first anticlinal belt advancing N. is that of the long and wide cove or valley of Umbral red shale, entering the region from towards the Lehigh between the E. spur of Spring Mountain and Pismire Hill, and occupied by Laurel Run and the Indian House swamp. This main anti-

clinal axis, leaving the Red-Shale Valley by a hollow in its N.W. corner, N. of Pismire Hill of Beaver Meadow, pursues its course Westward through the crest of Pismire Ridge, or the ridge which at the turnpike road separates the North Beaver Meadow from the Dreck Creek basins. Reaching the waters of the Catawissa, the flexure follows the denuded Red-Shale Valley of that stream to where it turns to run Southward, near the W. side of the Powell Lands; but how far it is prolonged into the Green Mountain of Catawissa, or whether it passes entirely through it into the Catawissa Valley, are points not as yet determined; it probably, however, dies out in Green Mountain.

From the cove N. of Pismire Hill, to Catawissa Creek W. of Cross Run, the anticlinal axis is arched only by the main conglomerate rock of the base of the Coal-measures, while E. and W. this stratum has been denuded along it, and the Red Shale is exposed.

Coal Basin No. 1, *or that of Beaver Meadow.*—Between Spring Mountain as a Southern boundary, and the above-mentioned anticlinal Pismire Ridge as a Northern, Basin No. 1 of the district, or that of the Beaver Meadows, occurs. As a detailed analysis of the structure and contents of this interesting coal-field will be introduced after this preliminary sketch, it will suffice to mention in this place that this basin is forked E. and W. by the intrusion of subordinate anticlinal axes penetrating it from both quarters, very much as the larger anticlinals enter and traverse the general table-land.

ANTICLINAL BELT No. 2, OR THAT OF CATAWISSA RIDGE.

This is a Western anticlinal, entering the coal region from the Red-shale district of the Catawissa. The axis appears to enter the table-land by the cove of Red Shale which divides the middle from the most southern of the three bold western knobs in the Green Mountain. Thence crossing the South Tomhicken or Mud Run, it ranges as a long straight anticlinal ridge between the Big Tomhicken and South Tomhicken of Catawissa on the S., as far at least as the Eagle Swamp; indeed, this axis is probably prolonged Eastward nearly to the Tamaqua and Wilkesbarre Road. The same general anticlinal belt, not carrying, perhaps, the same axis, but another a little N. of it, runs forward, in what is called Dreck Ridge, as far indeed as the passage of Hazle Creek, through this anticlinal. This Eastward extension of the anticlinal belt seems to terminate in East Pismire Hill, somewhere E. of Hazle Creek.

From the South Tomhicken to the neighbourhood of Eagle Swamp, the Western anticlinal of the belt, or that of Catawissa Ridge, exposes the upper beds of the Umbral red shale at various points along the axis, while at intermediate places this is overarched by the lower beds of the conglomerate.

Coal Basin No. 2.—This is the narrow and straight trough of lower Coal-measures confined to the valley of Dreck Creek, and to the same depression prolonged across the Tamaqua Road towards the W. It terminates towards Cross Run of Catawissa Creek, but a thin covering of Coal-measures extends N.W., forking off, as it were, from this basin, to lap across the Eastern subsided end of the anticlinal of the Catawissa Ridge westward of the Dreck Creek axis; thus uniting the Dreck Creek basin proper with a long narrow synclinal belt of Coal-measures of the Big Tomhicken stream N. of the Catawissa Ridge. It is this oblique passage of a strip of Coal-measures from the Dreck Creek basin into that of Big Tomhicken, which has led to the prevalent error of these being one and the same basin extended.

ANTICLINAL No. 3, OR THAT OF COUNCIL RIDGE AND LITTLE TOMHICKEN VALLEY.

This anticlinal belt, dividing the third or Hazleton basin from that of Big Black Creek, is composed of apparently three anticlinals, not strictly continuous with each other, but each more Western one originating a little N. of that next E. of it.

The FIRST axis of the belts, advancing from the Lehigh, enters the table-land of conglomerate and coal N. of East Pismire Hill, and passes through the deeply-excavated gorge in the mountain called the Owl Hole. Further W. it is the anticlinal of the high broad ridge crossed by the Rockport and Conyngham Road, which is sometimes called Council Ridge, and which I propose to entitle East Council Ridge. This axis here forms a broad crest of conglomerate. S.W. of the new colliery village called Fillmore, a small oval patch of Red Shale is exposed by denudation ; on the line of this axis, and a little further W., the saddle enters the Red-Shale Hollow in the Eastern end of the true Council Ridge.

The SECOND or middle axis of this anticlinal belt is that of the true Council Ridge, or the broad long hill which separates the Hazleton from the Black Creek coal-basins. This anticlinal is traceable from the wide deep Red-Shale cove excavated in the end of the ridge, Westward as far probably as Cranberry Creek ; indeed, it is not improbable that it and the anticlinal of Little Tomhicken Valley, traceable Eastward as far as Cranberry Creek, are one and the same axis.

It elevates the upper Umbral rocks, sometimes the upper layers of the Red Shale, and sometimes the yellow sandstones which lie between these and the conglomerate, in a narrow belt along nearly the entire length of the summit of Council Ridge, the N. and S. slopes of the wave being formed of the conglomerate.

The THIRD division of the third anticlinal range is traceable Eastward through the regular Red-Shale cove or valley of Little Tomhicken Creek to about the Western side of the Powell Lands, beyond which Eastward the axis is saddled by conglomerate for almost its entire distance to Cranberry Creek. Only in one place, or less than a mile W. of that stream, do the lower Coal-measures encroach from both sides towards the summit of this anticlinal arch.

Coal-Basin No. 3, *or that of Hazleton.*—This, apparently the most capacious of the coal-basins of the district enclosed between the anticlinal ranges Nos. 2 and 3, extends as a continuous but somewhat complicated belt of coal strata from a little E. of the Board Yard in the valley of Hazle Creek westward even to the junction of the Little and Big Tomhicken. It seems to terminate E. in two blunt prongs, divided by a broad low anticlinal of the conglomerate, and subsides a few hundred yards to the N.E. of the Board Yard. Westward it forks in a much more conspicuous manner, being separated by an anticlinal ridge of conglomerate at Cranberry into two long branch basins, the more Southern one ascending Eagle or Cranberry Creek, and prolonging itself through the valley of Big Tomhicken, while the more Northern, ranging W. and N. of Long Run, terminates in the Powell Lands north of the Horse-shoe Swamp, in the watershed which feeds the Sandy Run of Black Creek, and the Little or North Tomhicken. Connected with this third synclinal belt of the Coal-measures are the two Southern small basins of the Buck Mountain Company, on East Pismire Hill.

ANTICLINAL No. 4, OR THAT OF EAST BUCK MOUNTAIN, BLACK CREEK RIDGE, AND RACOON VALLEY.

In this general anticlinal belt, the individual axes of elevation are less connected than in any of the preceding ones. At least two anticlinals lift the conglomerate between the W. head of the Red Shale cove of Sandy Creek of the Lehigh, and the Coal-measures of Cross Creek flowing into Black Creek. The rapid subsidence W. of these axes allows the lower Coal-measures to spread themselves in a broad high undulating tract W. of Cross Creek, and between the better-defined valleys of Black Creek and Little Black Creek.

Further W. in this tract of Coal-measures originates an anticlinal ridge, called Black Creek Ridge, lifting the conglomerate between the two valleys, about 2 miles E. of the Wilkesbarre Road. This, which may be regarded as the middle axis of the belt, crosses that road at its intersection with Muddy Run of Big Black Creek, ranging thence W. until it expires somewhere N. of the mouth of Little Black Creek. This anticlinal exposes a broad belt of the conglomerate, divided in its centre by a long narrow oval tract of the red shale, exposed by denudation of the conglomerate where the axis is highest.

The third special axis of the belt is one which penetrates the table-land E. from the Red Shale Valley of Racoon Creek, exposing the red shale as far as to within a mile or less of the N.W. corner of the Powell Lands. The axis is saddled from thence to its intersection with Cranberry Creek by the conglomerates beneath the coal, this part of its course being along the flat summit of the broad ridge bounding the main Black Creek on the S., and which terminates W. in the synclinal spur called the Little Sugar Loaf Mountain. This anticlinal seems to subside somewhere S. of the junction of Little and Big Black creeks, its range being considerably S. of that of the middle axis of the belt.

Coal-Basin No. 4, or that of Big Black Creek.—This division of the coal-field lying between the anticlinal range of the Council Ridge on its S., and that of Black Creek Ridge and East Buck Mountain on its N., consists of two synclinal patches of the Coal-measures, the E., and by far the longest and most important, extending from near the Owl Hole westward, down the valley of Big Black Creek, to the intersection of this with Little Black Creek; the Western consisting of an unimportant narrow and shallow trough W. of Cranberry Creek, and heading near the sources of Barn's Run. From Jeddo westward to the mouth of Little Black Creek, the basin is of simple structure, but eastward it forks into at least three divisions, the most prolonged and widest of which is that of the Fillmore and Buck Mountain Northern Basin.

ANTICLINAL No. 5, OR THAT OF CONYNGHAM VALLEY.

The next and last main anticlinal belt traversing this coal district, is one which, ranging E. along the Conyngham Valley north of the Buck Mountain, penetrates the table-land of the coal-basins by the long Red Shale cove S. of the East Green Mountain. A continuous belt of the Red-Shale rocks extends from the Cove eastward, between Buck Mountain and Green Mountain, into the anticlinal valley of Swamp Creek, but whether lifted by the one axis of the Conyngham Valley, or met by another coming in Westward from the Lehigh, is a matter which must remain

for the present in doubt. This anticlinal is nowhere saddled either by Coal-measures or the conglomerate.

Coal-Basin No. 5, or that of Little Black Creek and Main Black Creek.—The next basin encountered in our progress Northward is a long and narrow synclinal belt of Coal-measures, extending from East Buck Mountain, east of Buck Mountain Creek, to West Buck Mountain, west of the deep defile by which Black Creek passes Northward out from the table-land. The Eastern half of this trough lies chiefly in the valley of Little Black Creek, and is sometimes called the Little Black Creek Basin. The Western half, from the entrance of Cranberry into Black Creek, occupies the valley of this latter stream the whole way to West Buck Mountain, heading Westward near the source of Robert's Creek. It is doubtful whether the E. and W. basins of this belt are actually united, though they belong strictly to one synclinal wave. It would seem rather, in the present imperfectly-developed state of the district, that the Coal-measures have been all denuded from out of the trough or basin above the junction of Big Black Creek and Cranberry.

Next its E. end the Little Black Creek Basin subdivides, an anticlinal upthrow of the conglomerate breaking it into two branches; one running towards the main Southern spur of East Buck Mountain, the other keeping a more Northern course towards the N. synclinal spur of the same range.

Coal-Basin No. 6, or that of East Green Mountain.—Between the anticlinal last mentioned, or that of the Conyngham Valley, and another axis situated in the valley of the Nescopec and Oley creeks, occurs the almost detached coal-field of the East Green Mountain. This embraces two distinct coal-basins, separated by a local anticlinal, which lifts the upper strata of the Red-shale formation to the summit of the mountain. The larger of these basins occupies the W. half of the Green Mountain, while the smaller, lying about one mile N. of the E. point of this main one, is seated just at the N. edge of the table-land, where it overlooks the valley of Oley Creek.

Coal-Basin No. 7, or that of M^c^Auley's Mountain.—In apparently the same general range or belt with the Western Green Mountain Basin, lies the remote insulated flat-topped mountain-basin of M^c^Auley's Mountain. Whether this is situated between the same anticlinals which enclose the coal-basins of the East Green Mountain, I am not prepared to say, and therefore deem it wisest, for the sake of avoiding errors of classification, to rank it separately. The limits of the coal in this basin will be defined in a future chapter.

Sugar-Loaf Knob.—Nearly in the same general synclinal belt with the East Green Mountain, and M^c^Auley's Mountain coal-basins, and just about midway between them, stands the Sugar-Loaf Knob, an oval conical synclinal hill, the mere peak or summit of which is capped, and protected by the hard lower beds of the Seral conglomerate. It contains no Coal-measures, but is interesting from its position in the line of the N. range of basins, showing as it does so unequivocally the prodigious devastation which the coal-rocks have undergone throughout all this district of country. The oval form of this hill is suggestive of its synclinal structure, its longer axis coinciding with the strike of the anticlinal and synclinal lines of the region.

CHAPTER II.

THE BEAVER MEADOW, OR SOUTHERN BASIN OF THE EAST MIDDLE COAL-FIELDS, OR COAL BASIN No. 1.

THIS complex synclinal belt, already defined as lying between the Red Shale range South of the Spring Mountain and the main anticlinal of Pismire Ridge, embraces several closely-connected subordinate coal-basins, or more properly one irregular basin undulated by several anticlinal waves into three connected troughs. These range from a little E. of the Mauch Chunk and Berwick Turnpike to the head-waters of the Catawissa Creek; the greatest length of the belt of Coal-measures being about 7 miles. One mile or a little more will express the average breadth of the coal-field from Beaver Meadow westward to the French village, though from Jeanesville to the latter point the two limits of the coal are about 1¼ miles asunder. The E. end of the general basins separates into two prongs or subdivisions, the more Southern and longer one occupying the valley of the main Beaver Creek south of the S. crest of Pismire Ridge, and extending apparently for half a mile E. of the village of Beaver Meadow; the more Northern branch heading a third of a mile Eastward of the turnpike in the table-land N. of the South Pismire Ridge and the main N. anticlinal of that range. The N. portion of this coal-field breaks, on the other hand, into three lesser basins, the centre one being by far the widest and longest. Of these, the most Southern, or the basin of South Beaver Creek, running forward past the German village, terminates, so far as the Coal-measures are regarded, about 1 mile nearly S. of the French Company's old sawmill. The middle and largest trough heads Westward towards the synclinal knob S. of Panther Run (?) somewhere upon that table-land, perhaps 1½ miles S.W. of the above-mentioned sawmill. And thirdly, the most Northern of the three lesser basins appears to have its W. end between the French village and the sawmill, about three-quarters of a mile from the former.

ANTICLINAL UNDULATIONS OF THE BEAVER MEADOW COAL-FIELD.

Two sets of anticlinals undulate and disturb the general Beaver Meadow basin, the one belonging to a group of important undulations traceable Westward from the Lehigh; the other, to two or more leading axes entering Eastward from the Red-shale district of the Catawissa Valley.

Eastern Anticlinals of the Coal-field—Anticlinal Axis A.—The principal Eastern axis A, passing through the S. crest of the Pismire Hill north of Beaver Meadow village, and through the Beaver Meadow Mines, follows the valley of West Beaver Creek, and dies out under the village of Jeanesville. This lifts the conglomerate into view on the turnpike a little S. of the Catholic church; it forms the nearly perpendicular N. dip in the centre of the old Beaver Meadow Mine, and carries this N. or perpendicular dip along the valley of West Beaver Creek to the Jeanesville Colliery No. 1, where, by the dying down of the axis, the large coal thus lifted turns suddenly S., and saddles itself, basining again between this axis and the anticlinals next S. of it.

The Old Open Cut Mine of the large Beaver Meadow coal-bed was wrought upon the back of this anticlinal. Slope No. 4 is likewise situated upon it. Near this last-named colliery, the denudation which cut the valley of the West Beaver Creek, sweeping away the large coal from the anticlinal axis, has caused its S. and N. outcrops slightly to diverge; the S. outcrop taking the foot of the hill S. of West Beaver Creek and of the railroad, until it approaches the N. descending ravine half a mile E. of Jeanesville. Before reaching this point, the denudation of the measures at the ravine has swept away the Big Coal, causing its basin to terminate there.

Anticlinal Axis B.—S. of the anticlinal we have just traced, there ranges another which, entering the Coal-measures N. of Beaver Meadow village, in the broad S. shoulder of the Pismire Hill, passes Southward of the outcrop of the great coal-bed of the Old Beaver Meadow Mines, forming the Southernmost of the two nearly perpendicular N. dips which undulate that mass of coal. It is this axis apparently which courses N. of the Colerain Colliery Breaker, and through the N. side of the flat-topped hill, over which runs the Beaver Meadow and Tresckow Road, and which appears just S. of the tunnel on the Wharton Vein, in the ravine or hollow half a mile S.E. of Jeanesville. This axis probably expires in the South Jeanesville Basin, more correctly the middle trough of the coal-field, somewhere near or W. of the Tamaqua Turnpike. Throughout its range it is nowhere oversaddled by the Great Coal-seam, but lifts the next lower measures to the surface, the point of nearest approach of the outcrops of the large coal-bed being just N. of the summit of the high flat knob containing the flattest S. dips of this anticlinal.

Sub-Basin A, *or that of Axes* A B.—The E. extremity of this basin is a mere flat synclinal table at the S. foot of the conglomerate N. of Beaver Meadow village, and deeply denuded of its Coal-measures at the head of the Sand Spring ravine. It contains none of the Big Coal until we go about a quarter of a mile W. of the turnpike; there the basin receives the E. end of the S. trough of the large coal of the Beaver Meadow Mine, the outcrop of this coal being discernible a little E. of Ratcliff's New Slope, on the railroad leading to his Breaker. Contracted at the passage of West Beaver Creek across the basin, the Big Coal expands in the trough again W. of the stream and the railroad, and forms there a trough between the base and the brow of the hill, terminating by denudation, as already intimated, E. of the next W. ravine. The lower Coal-measures of course are not thus circumscribed in the basin, but extend from one bounding anticlinal to the other. It is within this basin at its W. extremity, or near the Tamaqua Road, that a small anticlinal undulation intrudes itself almost on the parallel of the old colliery in the ravine, and S. of the main W. anticlinal which separates the Big Coal into two outcrops at Jeanesville Colliery No. 2. This short subordinate anticlinal, by throwing out the large coal into diverging outcrops E. of the turnpike and in the ravine, conspires, with the previously-traced axis B, or that of the Wharton Vein Tunnel, to cut off the large coal E. of the ravine entirely from that W. of it. It furthermore, by lapping past the E. point of the main axis—that of Slope N. 2—causes the middle basin, or that S. of the axis, to swing its outcrop of the large coal, and the mine gangways upon it, abruptly Southward near the turnpike.

Anticlinal Axis C.—A small anticlinal flexure, parallel with that last traced, and, like it, passing through the shoulder of Pismire Hill just N. of Beaver Meadow village, crosses the ravine of the Sand Spring and that of West Beaver Creek, and shows itself on the road just at

Colerain. It is probably this roll of the strata which disturbs the course of the gangways in the W. end of the Cleaver or Ratcliff Mine.

Basin b.—No defined basin is traceable between the anticlinals B and C from N. of Beaver Meadow to Colerain, the data being too imperfect; but the undulated dipping of the lower Coal-measures W. of Beaver Meadow intimates that this basin is present even there; but W. of Colerain we see it unequivocally exhibited in the flat synclinal hill over which the main road passes. Here there occurs a small insulated patch of the large coal-seam, scarcely covered by a sufficient thickness of strata to admit of being profitably mined. On its N. edge this little basin of the Big Coal shows a S. dip of 30°; but this quickly flattens, and there is scarcely any decided N. dip belonging to the anticlinal C to the S. of it.

Other undulations seem to occur between the crest of Pismire Hill and the N. edge of the meadows of Beaver Meadow Valley, but the ground is altogether too obscure to permit our tracing them with any clearness. They undulate the lower Coal-measures N. and W. of Beaver Meadow village, and will greatly interfere with the successful mining of the one or two otherwise workable coal-seams of that neighbourhood.

Anticlinal Axis D.—A fourth regularly traceable E. axis, situated to the N. of the main saddle A of the Pismire Hill, emerges W. from the N. side of that ridge, crosses the turnpike not far from the Catholic church, and descends into the valley of North Beaver Creek. On the S. edge of this little valley it exposes, at Slope No. 8 of the Beaver Meadow Mines, a regular broad saddle of the large coal-bed. About one-fourth of a mile further W., it passes N. of the Old Slope No. 1, and beyond this it gradually flattens away or expires in the North Beaver Meadow Basin, or North Jeanesville Basin, somewhere S. or W. of Slope No. 7. This anticlinal, therefore, divides the North Beaver Meadow Basin into two branches at Slope No. 8, the S. branch being the N. basin of the old mines, and the N. branch, the separate narrow trough of the Big Coal, following the valley of North Beaver Creek from that point to the neighbourhood of the old tavern on the turnpike.

Basins of Axes A *to* D, *and of* D, *and of Main Axis No.* 1.—Little need be said in addition to what has just been stated of the two basins separated at Slope No. 8 by the intermediate axis D. The E. outcrop of the large coal of the old mines, in the more S. of these two branch-basins, approaches within about a fourth of a mile of the turnpike; while the same thick seam in the trough next N. almost reaches to the road. Thus all the three branch-basins of the large coal, the two of the old mines, and that of North Beaver Creek, terminate very nearly on the same meridian, or the same N. and S. line.

WESTERN ANTICLINALS OF THE BEAVER MEADOW COAL-FIELD.

In the W. half of the general synclinal belt embraced between the leading anticlinals Nos. 1 and 2, there enter the coal-field from the W. at least two separate anticlinal axes, which, with the N. dip from Spring Mountain, and the S. one from the anticlinal of Pismire Ridge, form the three branches into which the general coal-basin divides itself W.

The most Southern of these anticlinals, which we shall designate by the letter E, issuing from the Red-shale country of the Catawissa, enters the table-land of the coal strata by the hollow which divides the W. end of the Spring Mountain into two knobs. Passing thence across the head-waters of a S. tributary of the Catawissa, where denudation lays bare the Red Shale, else-

where covered on the back of the anticlinal wave by the conglomerate and the Coal-measures, as already indicated, the axis is saddled by the coal-rocks about a mile S. or S.E. of the French Company's old water-driven sawmill. From this point E. to the Tamaqua Turnpike, and indeed to the Tresckow and Beaver Meadow Road, the line of this saddle is plainly indicated by a swell of the ground, dividing the valley of the South Beaver Meadow from the head stream of the Catawissa on the W., and the waters of West Beaver Creek on the E. At the source of the Catawissa, or one mile W. of the turnpike, this anticlinal axis, accurately determined in position by shaftings for coal on the York Company's land, lies just 3200 feet S. of that company's Slope Colliery No. 1. At the turnpike it lies a few hundred feet N. of the Tresckow Hotel, and on the road thence to Beaver Meadow its intersection with this latter road is about 3000 feet E. of Tresckow, and apparently just N. of a shaft and boring undertaken by the German Company in quest of the large coal. Further E. than this point it is not at present traceable.

Coal Measures on Axis E.—From the point on this saddle S. of the French sawmill, where the lowest of the coal strata first roll over the conglomerate, all the way to its point of disappearance Eastward, it would appear to be nowhere overarched by the large coal, or that of the Old Beaver Meadow Mines, but to be overlapped only by the underlying Coal-measures. At the shafting S. of the York Company's Slope, the two coal-beds next beneath the Big Seam are alone made to outcrop on the opposite sides of this axis. The lowest of these coals, just adjoining the anticlinal line, measured, it is said by those who did the shafting, 9 feet in thickness upon both outcrops. The other, or that which next underlies the large bed, measures, according to the same good authority, 8 feet in thickness also on both its outcrops.

Further E. along the axis, it would seem that the denudation E. of the Tamaqua Turnpike, or N. of Tresckow village, has laid naked a third underlying coal, or one next inferior in position to that opened at the axis further W. At Tresckow these three veins are severally 5 or 6 feet, 4 feet, or 4½ and 8 feet in thickness. The occurrence of coal so low in the series, so far E. as the road from Tresckow to Beaver Meadow, militates strongly against the probability that the German Company will find the large coal upon their estate either N. or S. of this axis. Our cross section of the district will show that the three lower coals, here described, occupy the whole N. side of the valley of Beaver Creek, even to the stream itself; and it is impossible to conceive that the great or thick bed can find room to basin above them in the centre of the valley, where the dip of the strata is known to be nearly horizontal. The only possible condition under which the large coal can occur on the German property, is as a bed beneath, and not above, the three smaller seams indicated in the Section; but these are almost certainly the lower coals, or those next above the conglomerate, as may be seen by noting the close proximity of that rock to the S. edge of the bed of the valley at Tresckow, and its gentle Northward dip there, conditions which almost preclude the admission of any such series of coals as the hypothesis of the presence of the large bed beneath these three of the section would imply. The exclusion of the large coal from the anticlinal N. of Tresckow may be considered as furthermore demonstrated when we trace the uppermost of the three beds at Tresckow from its place in the bed of the South basin, continuously by the bench it forms and the shaftings made upon it, to the Slope Colliery seated upon it W. of the road, and thence again to the shaftings one mile further W., and there identify this South-dipping seam with the 8-feet-thick bed on the N. side of the axis, seen dipping unequivocally N. below the S. outcrop of the Big Vein in the Middle or York Company's Basin. The amount

of uplift at this anticlinal, and the deep and wasting denudation of the strata along the whole line of the valley of South Beaver Creek, have left this basin apparently without a trace of the large Beaver Meadow coal-bed. If a narrow strip of it does exist, it can only be under the marsh or Beaver Meadow opposite the town, and perhaps for a mile W.; but that even such is the case seems to me quite improbable.

Basin c, or that of South Beaver Creek.—Little need be said in addition to the observations just made respecting the coal contained in the South Beaver Meadow Basin, or that which, further W., is the basin of the German Company. It has been already stated that the Eastern termination of the coal in this trough is a little E. of Beaver Meadow village, and that from E. of Tresckow, Westward to the end of the basin, none but the two or three lowermost coal-beds lie within it. What remains to be said, relates to the more central part of its range, or that of the neighbourhood of Colerain. A little E. of this place is the old and now suspended colliery, No. 3 of the Beaver Meadow Company, wrought in a South-dipping bed of coal some 9 feet in thickness, demonstrably a lower coal than the large vein of the Beaver Meadow Mines. This is, in other words, the Wharton Slope upon the Wharton Vein, generally admitted to be the next under the Big Coal. Half a mile to the W. of this slope occurs the Eastern extremity of a Southward-sloping basin of the Big Coal bed, lying between the Beaver Creek Valley and the Beaver Meadow and Tresckow Road, and capped at this E. end by Cleaver's (now Ratcliff's) Mine-drifts. This basin of the Big Coal I regard as resting in the trough between axes B and C of the hill N. of it, and the Eastern prolongation of the Northern axis C, or that just N. of Tresckow; and I conceive that the influence of this last-named anticlinal is to exclude the large vein entirely from the neighbouring valley of the South Beaver Meadow Basin. The gradual subsidence Westward of the small axis C, or that N. of the Wharton Slope, allowed a sufficient depression or synclinal trough between the two saddles B and C to preserve from total destruction, by denudation, this small narrow basin of the large coal now wrought by Ratcliff.

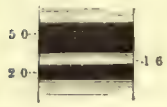


FIG. 204.—Wharton Creek E. of Jeanesville.

Anticlinal Axis F, *or that of Jeanesville.*—The more Northern of the two anticlinals which penetrate the Beaver Meadow Coal-field from the W. is one apparently of great length and straightness. Terminating as already indicated just at Jeanesville, it comes Eastward from the Red Shale Valley of the Catawissa, following the main creek to a mill, and thence the same valley—no longer occupied by the creek, however—to Clark's. It crosses the Catawissa higher up, near the mouth of Panther (?) Run, from which it pursues the valley of this tributary until it once more intersects the Catawissa, now near its source, at the old sawmill of the French Company, $2\frac{1}{4}$ miles W. of Jeanesville. About half a mile E. of the sawmill, the Coal-measures seem for the first time to saddle themselves across the anticlinal axis; first, only the lowest coal-beds, and opposite the French village, the highest of this inferior group, or the seam next beneath the large one. It is not until we approach the position of the Jeanesville Slope, No. 2, that the large seam unites its two outcrops to arch itself at the anticlinal axis. This saddle appears to die out altogether a few hundred feet E. of the turnpike at Jeanesville, the workings in Mr Milnes' Colliery proving that it expires in the basin S. of his old slope, No. 1.

Basin C, *or that of the York Company, and the Jeanesville South Slope Mine.*—Between the two principal Western anticlinals E and F is embraced by far the largest of the Western basins of the Beaver Meadow Coal-field. Commencing our description of it at the ravine S.E. of

Jeanesville, where several of the smaller Eastern anticlinals break it up, and tracing it to its Western termination in the Powell Lands, it has a length of probably 4½ miles. Its breadth at the widest place, or where the Coal-measures saddle both its bounding anticlinals—namely, opposite the French village, and for a short distance Westward—is about 3700 feet. From a little West of the turnpike to its Western limit, this basin, so far as we know it from the hitherto imperfect developments made within it, is a simple synclinal trough, without any included saddles, of serious magnitude at least, to undulate its strata. The highest coal-seam which it contains is apparently the one which next overlies the large bed—in other words, the fifth ascending of the series as at present ascertained. The only place at which this coal has hitherto been opened is on the York Company's ground, 2000 feet S. of the French village; it is nearly in the centre of the basin. How far this ranges E. and W. is not known. Both the N. and S. dips are very gentle, or only 10° or 12°, but at the foot of the slope the dip is 24°.

Extent of the Big Coal in the Middle Basin.—Venturing now upon an approximate tracing of the limits of the large coal-bed, we find the basin, as already stated, cut off by the ravine E. of the turnpike near Jeanesville, so that in this direction the E. outcrop does not lie 1500 feet E. of the road. The N. outcrop of the Big Coal follows the N. main anticlinal from Jeanesville No. 2 Slope to a point nearly 2000 feet S.W. of the French village. There it leaves the vicinity of the anticlinal axis to range more towards the S.W., converging to meet the S. outcrop, running more nearly Westward. It is impossible, in the present unexplored condition of the ground, to state within a mile or more where the W. end of the basin of the Big Coal actually is; possibly it terminates within about a mile W. of the York Company's Slope No. 1; that is to say, a little E. of the denuded valley by which the stream draining this basin passes Northward to the Catawissa. Possibly also it extends for one mile Westward of this stream, or just into the Powell Lands; but if it does, the basin can have no profitable breadth or depth, for some coal-shaftings recently made show that nearly the whole breadth of the basin is occupied by the three lower coals. The total breadth of the belt of the Coal-measures at this point, the E. end of the Powell Lands, is about 1000 feet—a narrowness which almost necessarily excludes, even with a steeper dip, the large coal of the middle of the basin.

Respecting the W. limits of the lower Coal-measures—or, in other words, the W. extension of the trough formed by the upper beds of the Seral conglomerate—too little is known to permit me to venture more than a mere conjecture, founded on the topographical features of the ground. I think it probable that the two margins of the lowest productive Coal-measures, converging from the anticlinal bounding the basin, the Northern from about half a mile W. of the village, the Southern from about as far W., finally meet and form the end of their trough or basin about 2 miles W. of the French Company's old sawmill, or one mile within the Powell Lands. Possibly the coal strata may extend one-third of a mile further Westward into the highest summit of the broad synclinal knob in which the conglomerate of this belt terminates; but the exact determination of the W. confines of the coal can only be reached by patient and systematic shafting.

Jeanesville Slopes.—In the vicinity of Jeanesville there are three slope-mines entering the Big Coal. The slope E. of the town descends at an angle of about 12° Southward. About 75 feet N. of the tip of the slope the measures descend upon a nearly perpendicular N. dip, and 300 feet N. of the slope the coal is cut in a perpendicular shaft. The coal crops out on the N. side of the basin about 500 feet N. of the shaft. This sharp anticlinal roll seems to decline rapidly

going Westward, and will cause a deflection Southward of the gangways. The coal is also worked from a shallow basin S. of the foot of the slope, and over a saddle into S. dips again.

West of the town about 1000 feet are two slopes on the contrary dips of an anticlinal over which the coal is laid bare in an open cut. This roll seems to decline Eastward, for the coal cannot be traced beyond the slope E. of the village. If this be the case, it will affect the direction of the gangways driven Eastward. The dip on the N. side of the axis at the slope is 25°, at the top steepening to 45°. In the S. it is from 25° to 30°.

In the open-cut the following measurements of the Big Coal were taken :—

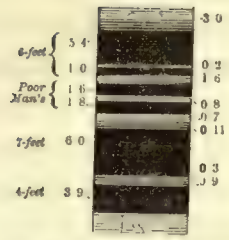


FIG. 205.—Big Coal, Jeanesville, at "Open Cut."

		Feet.	Inches.
	Slate and bony coal,	3	0
6-feet bench	Coal, good,	5	4
	Bony coal,	0	2
	Coal, good,	1	0
	Coal, bony,	1	6
	Slate,	0	2
	Coal, impure,	1	6
	Slate,	0	8
Poor Man's—	Coal, very good,	1	8
	Slate, fissile,	0	7
7-feet bench	Coal, bony and slaty,	0	11
	Coal, good,	6	0
	Slate,	0	3
4-feet bench	Coal, bony,	0	9
	Coal,	3	9
	Slate,	...	

The divisions of the large bed are nearly constant. At the Beaver Meadow Mine the Section reads as follows :—

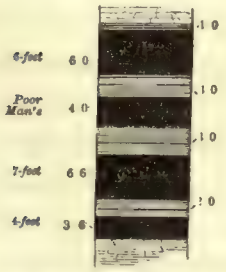


FIG. 206.—Big Coal, Beaver Meadows.

Rock cover,	...
Bone, 1 foot,	1 foot.
The 6-feet bench,	6 feet.
Coal, and slate, and bone,	3 „
Poor Man's Coal,	4 „
Coal, and bone, and slate,	3 „
The 7-feet bench,	6½ feet of coal.
Bone and slate,	2 feet.
The lower 4-feet averages,	3½ feet of coal.

JEANESVILLE.

Coal and slate worked together (of which 2 feet 3 inches is coal),	14 feet.
The 7-feet coal,	7 feet.
Slate,	½ foot.
The lower 4-feet bed has	5 feet of coal.

Shaftings on the North York Company's W. tract, beginning on the N. side of the basin :—

1st. A shaft about 300 feet S.; conglomerate; coal and coal-dirt, 5½ feet; bottom of fireclay, with *Stigmaria;* S. dip 35°. Forty yards S. of this first is the

2d Coal, 4 feet thick; fireclay bottom, with *Stigmaria;* S. dip 35°; then it is about 20 yards to the

3d coal, shafted to 7 feet of coal and dirt. It is about 45 yards to the

4th coal. It showed 6 inches of coal, with black dirt and slate.

North Beaver Meadow Basin, or Basin g.—The Northern division of the Beaver Meadow Coal-field, or that which receives the South-dipping strata of the S. flank of Pismire Ridge (not Pismire Hill, N. of Beaver Meadow village), is bounded, as we have already seen, by the anticlinal axis A from the Beaver Meadow Turnpike to the Jeanesville Slope No. 1, while Westward from Jeanesville it is bounded Southward by another anticlinal F, not strictly in prolongation with A, but a little S. of it. This basin towards it E. end is divided into two short branches by the intruding axis D: its W. portion, on the other hand, is enlarged at Jeanesville by the dying-out of axis A, and by the rising of axis F further Southward.

Limits of the Big Coal in the North Beaver Meadow Basin.—The S. limit of the Big Coal in this basin coincides very nearly with these two anticlinals D and F, until we pass a little distance W. of Jeanesville. There the outcrop of the Big Coal, running Westward, diverges from the anticlinal F, and when within from 1000 to 2000 feet of the French village, it terminates or swings round, and joins the N. outcrop. This Northern limit of the large coal, commencing a little W. of the Beaver Meadow Turnpike, and ranging first South-westward, passes slope No. 7 of the Beaver Meadow Mines, beyond which it takes a somewhat more Westerly direction, until within one-fourth of a mile of the Wilkesbarre Road at Jeanesville. It crosses the railroad, intersecting the turnpike about 400 feet N. of the creek in Jeanesville. This outcrop very gradually curves more and more Southward in the direction of the French village, until it meets the S. edge of the coal already traced, somewhere in the space above mentioned E. of the French settlement, and in the neighbourhood of the York Company's Branch Railroad. Upon this view of the W. limit of this valuable basin of the large coal, it scarcely enters the French Company's lands. The total of the trough thus assigned to it is a little less than 3 miles.

The Eastern and Western limits of the lower Coal-measures belonging to this North Beaver Meadow Basin have been already indicated; the first was stated to occur within half a mile E. of the Beaver Meadow Turnpike, and the last about three-fourths of a mile W. of the French village.

Dreck Creek Coal Basin, or Basin No. 2.—Very few particulars can be given respecting either the precise limits or the contents of this comparatively unimportant belt of Coal-measures. Lying on the N. slope of Pismire Ridge far Westward in the shallow valley of Dreck Creek and its Westward extension, this strip of the coal-rocks would seem to embrace no portion of the large or Hazleton Coal-bed, but only some of the underlying Coal-measures. The valley seems to be denuded of even these strata everywhere Eastward of a point less than 2 miles E. of the Berwick Turnpike. How far Westward they actually continue in the basin is a point not ascertained, the acknowledged absence of the large coal having withheld inducement to any artificial trials in quest of such coal-beds as may exist. True coal-rocks seem to extend, however, along the N. side of Pismire Ridge nearly to Cross Run, or opposite the Eagle Swamp. A coal-bed, probably the lowest in the series, has been opened in the basin by shaftings, but the coal was not fully proved.

Fig. 207.—East End of Spring Mountain.

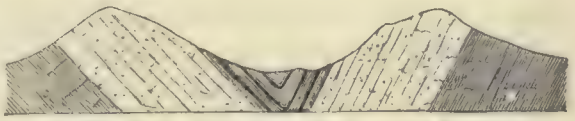


Fig. 208.—Spring Mountain at Confluence of Beaver and Dreck Creeks.

Note.—The above two cuts (figs. 207, 208) omitted at the proper place of insertion (see p. 245), exhibit the slenderness and closely-folded structure of the South Beaver Meadow, or Spring Mountain Basin, towards its E. end. The Coal-measures displayed are not productive.

CHAPTER III.

THE HAZLETON BASIN AND ITS BRANCHES, OR BASIN No. 3.

It has been already stated, in our general account of this basin, that it forks both Eastward and Westward through the intrusion of subordinate anticlinals. It is expedient that we indicate the position and the effects of these, as essential to a clear understanding of the limits of its coal strata.

ANTICLINALS H AND J.

Turning our attention first to the E. extremity of this coal-field, an anticlinal axis, H of the Map, ranges through the middle of the East Pismire Hill in the Buck Mountain Company's estate, dividing the Southern coal-field of that Company into two basins—their Basins No. 1 and 2, or H and I of our nomenclature. (See Cut, fig. 209.)

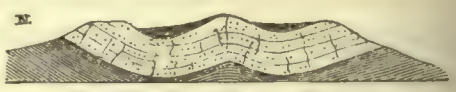


Fig. 209.—Buck Mountain Basins, East Pismire Hill.

The effect of this saddle is barely to separate the Large Buck Mountain Coal of these basins into two outcrops, which at their nearest approximation almost unite upon the axis. Between these basins the anticlinal wave is comparatively of gentle curvature, but W. of the termination of the smallest, or Southern basin, the dips upon its two sides grow steeper; that of the S. edge of the Northern, or basin I, being as sharp as 45°.

Another anticlinal, J of the Map, lies directly in the range of this axis H, and in all probability is but the W. prolongation of it; and my only reason for not designating them upon the Map as one axis is, that the intervening country being obscure as respects the dips, and there being little or no coal in it to incite to any explorations by digging, the actual continuity of the anticlinal has not been yet established.

This anticlinal J divides the E. extremity of the proper Hazleton Coal Basin into two short and broad, but shallow branches, the S. one, or that of the Board Yard on Hazle Creek, being seemingly the longest. As far W. as the road leading N. from the Board Yard to Jeddo, this anticlinal is overspread by very gently-dipping beds of the conglomerate; but a little further W. the lower Coal-measures probably close over the axis. The effect of this saddle, thus opposing itself to the E. prolongation of the Hazleton Basin, has been to lift out the Coal-measures, or to expose all but the very lowest of their strata to a wasteful denudation. The mere flattening-up of the bottom of the basin in Hazle Creek at the W. subsidence of this saddle, has had the effect, of course, of exposing to removal the whole of the upper Coal-measures, with the Big Coal included. This axis is traceable to within one-third of a mile E. of Stockton Colliery.

Fig. 210.—Section one mile East of Hazleton.

Basin h, or No. 1 of the Buck Mountain Company's Lands.—This small basin of the Buck Mountain Coal, now nearly wrought out, lies on the S. summit of East Pismire Hill, just E. of the Conyngham Road. The basin, tapering to a narrow point E., has had all the coal removed from its broader W. end. It is a symmetrical little trough of the large coal, the N. and S. dips

being nearly equal, and about 25°; its length is about three-fourths of a mile. This Buck Mountain Company's coal-bed is here evidently the lowest productive seam of the series. It lies only a short distance above the conglomerate, and there are no traces of any other coal-bed underlying it. Nevertheless, it is by many persons regarded as the equivalent of the great Coal-seam of the Hazleton Basin, the chief reasons alleged being that the coal itself is too pure for either of the lowest or underlying seams; and moreover, that it contains the same three benches into which that thick mass is invariably subdivided. I cannot, however, adopt this view for the following reasons. In the first place, it implies too abrupt a change in the Coal-measures, for it assumes that nearly all the strata between the conglomerate and the great coal—that is to say, three beds of coal and their three thick overlying masses of strata, ponderous conglomeritic sandstones chiefly—should all vanish on account of an original deficiency of material, within the short space of 5 miles from where we know the series to be full and complete.

In the second place, it presupposes that the presence or the absence of the bird's-eye structure is a more permanent characteristic than it truly is, not considering that this is an accidental consequence of a peculiar stage of metamorphism, and not an inherent condition belonging to special beds of coal throughout their whole extension. That this bird's-eye fracture, so usually accompanied by thin perpendicular scales, or pellicles of pure white silica in the little fissures, is not an original feature of the coal, but a superinduced one, is manifest, from the fact of its crossing or cutting, and not coinciding with, the lamination or plates of deposit of the coal. It has evidently been introduced long subsequently to the deposition of the coal-beds at the period of their upheaval, consolidation, and metamorphism.

The argument asserting the identity of the Buck Mountain Coal with the large Hazleton Bed, from a correspondence between the two as respects their benches, overlooks the fact that at various points both in the Hazleton and the Beaver Meadow coal-fields, the lowest coal of the series is similarly compounded, and made up of three separate layers or benches, as may be seen by consulting the statements made respecting it in these Chapters.

Basin i, or No. 2 of the Buck Mountain Company.—This basin commences somewhere within one mile E. of the Conyngham Road, and just N. of basin *h*. Its W. termination, not yet established, is a little W. of the West line of that Company's lands, or about 2 miles N.E. from the Board Yard. Its greatest breadth opposite the New Slope, from outcrop to outcrop of the Big Coal, is from 800 to 900 feet, and here the dip of the strata is on both sides about 45°. Notwithstanding the seeming regularity, there occurs within the basin an anticlinal roll, the coal-bed being lifted in a saddle just in front of the bottom of the mine slope. So abrupt an arrest to the further progress of the slope, required the cutting of a short tunnel across the saddle to intercept the main N. dip by which the coal descends into the bed of the basin.

Coal of the Buck Mountain Company's Basins.—This coal-bed, as already stated, is composed of three separate benches or seams, the dimensions of which are as follows:—

An upper bench, . .	9 feet thick . .	Good coal.
Slate, . . .	2 „ „ . .	...
A middle bench, . .	5 or 6 „ „ . .	Coal a little rough.
Slate, . . .	A thin parting. . .	...
A lower bench, . .	2 or 2 feet 6 inches. . .	Rough and bony coal.

Basin j, or that of the Board Yard.—Precisely how far to the E. this shallow Southern branch of the main basin ranges, is not at present known; but it ceases probably within $1\frac{1}{2}$ miles E. of the Board Yard.

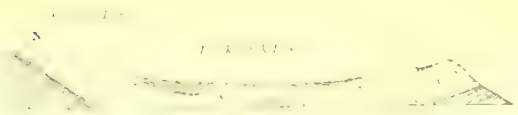


FIG. 211.—Hazleton Basin, E. of the Board Yard.

Towards the N. side of this trough a coal-bed has been proved a little S. of the conglomerate of the anticlinal, at a point about 300 yards N.E. of the Board Yard. The coal-seam reached at a depth of 17 feet, and dipping S. with a gentle angle, has a thickness of 6 feet 4 inches. It is a rough coal, with the ordinary bird's-eye fracture so common in the lowest coal-seams of this district. This is probably Coal No. 1 of the series. The width of the basin at this point, or to the S. outcrop of this same lowest coal near the railroad, is about 400 yards.

Another outcrop of a coal-bed has been caught by shafting at a point about half a mile W. of the Board Yard, near the railroad. Some persons have conjectured this to be the Main Hazleton Coal; but there is no actual evidence as yet that the large coal extends so far down the valley of Hazle Creek, no actual openings having been made upon it E. of the Stockton Mines.

Basin k.—The North Branch of the E. end of the Hazleton Basin is evidently a short and shallow recess from the main basin N. of the anticlinal J. Coal has been lately found in this basin a little W. of the road leading past its E. end to Jeddo. The bed, whose outcrop is not far S. of the North-bounding outcrop of conglomerate, has been reached by a shaft 18 feet deep, the top rock being a loose grey sandstone, somewhat pebbly. The coal, evidently the lowest of the series, has a total thickness of 9 feet. It consists of—

	Feet.	In.		Feet.	In.
A top bench, . . .	2	4	Slate, ...	0	6
Slate, ...	0	6	A bottom bench, . .	3	0
A middle bench, . .	2	6			

This coal is of medium quality, inferior to the great bed of Hazleton, but not the rough bird's-eye coal so generally characteristic of the lowest seams. The dip of the bottom slate being 60°, and of the top rock 45°, the coal-bed is evidently squeezed, and this is indicated by the slippery surfaces of the fragments.

Anticlinal M, *or that of Crystal Ridge.*—The next anticlinal which we meet with in our progress Westward is a short one, which belongs to the S. margin of the basin N. of Hazleton. It seems to originate somewhere E. of the Tamaqua Road in the lower Coal-measures S. of the outcrop of the great bed. Advancing Westward, it enters the area of the main seam, probably near the head-stream of Cranberry Creek. Within this interval it arches the Big Coal under the surface, and thus undulates it as far as Boyd's Run, beyond which the denudation having cut away the overlying strata, the Big Coal is at the Crystal Ridge Colliery, and for some distance E. of it, cut into two outcrops. Still further Westward, by the subsiding of the anticlinal, these two outcrops coalesce again, and the saddle which they once more form, droops, and finally expires in the valley of the South Hazleton Basin. The somewhat oblique course of this saddle to the strike of the coal, but especially its sinking Westward, causes the level gangways of the Laurel Hill Colliery, pushing Westward beyond Hazleton, to encounter first its N. flank, and finally its summit, compelling them to pause or turn.

Anticlinal N, *or that of Cranberry Ridge.*—The W. part of the Hazleton Basin is subdivided,

as already mentioned, into two long branch basins, and the anticlinal which produces this forking is that of Cranberry Ridge, an irregular ridge saddled by the conglomerate from near the Cranberry Works westward. This axis, originating somewhere in the main Hazleton Basin W. of the town of Hazleton, first divides the Coal-measures, or lifts the conglomerate to the surface near the E. end of this Cranberry Ridge: one mile further Westward, the axis seeming to subside a little, the lower Coal-measures shut together over the line of the saddle for a short space, but presently divide once more into two outcrops going Westward, the Southern one diverging a little from the axis, and running forward to constitute the N. outcrop of the Tomhicken Basin; and the N. receding still more rapidly from it until it crosses the head-waters of Long Run, and reaches those of Stony Run, forming in this line the S. margin of the N. branch of the Hazleton Basin. This axis would seem to be the cause of the two opposite dips visible near the Cranberry Shaft. There is, however, within the mine S. of the shaft, a subordinate undulation or roll of the strata, but it is no part of the main anticlinal.

Anticlinal O, *or that of Tomhicken Ridge.*—Another anticlinal, that of Tomhicken Ridge, enters the Hazleton coal-field from the W. This penetrates the N. broad branch of the Hazleton Basin north of Long Run, but how far E. it prolongs itself cannot at present be ascertained. Being near its expiration, where it enters the Coal-measures N. of the sources of Long Run, its only effect seems to be to spread wider the lower Coal-measures in the Northern Branch Basin. It is probably owing to this anticlinal that the N. outcrop of the large coal-seam is cut away as it is at Cranberry village, and excluded from entering the Northern Branch Basin, or that of Cranberry Creek. Whether this large coal sets in again W. of Cranberry Creek, is a matter not positively determined, some shafting being now in progress near the E. line of the Powell Lands, with a view to ascertain this. If it does indeed exist there, it must be N. of the Tomhicken axis, and therefore considerably N. of Long Run, which flows first S. of, and then across, that anticlinal. My own view is, that the North Hazleton Basin on the Powell Lands is too shallow to contain any vestiges of the great coal-bed.

Basin N, *or that of Big Tomhicken.*—The Main Hazleton Basin bifurcating, as already mentioned, by the intrusion of the Cranberry Ridge anticlinal N, sends forward to the W. a long narrow branch basin, which we designate by the letter N. This containing the Big Hazleton coal-bed about as far as the entrance of the small run called Eagle Creek, carries thence for several miles only a narrow and shallow strip of the lower Coal-measures in the middle of the valley of the Big Tomhicken. The dips in the basin are very regular throughout, its length growing somewhat steeper as we advance Westward along it, but nowhere receding 45°. Two or three shafts have been sunk on coal in this basin, one on its S. edge $1\frac{3}{4}$ miles W. of the Powell Lands, where the coal dips 35° N., but its thickness is doubtful. Another shaft reaches coal about half a mile W. of the Powell line. Near the E. side of this large estate, or where the Phinney Road crosses the basin, there remains in it but a small amount of the lower Coal-measures; but Eastward again the basin widens and deepens, and at Eagle Creek it receives the W. extremity of the basin of the large Hazleton Coal-vein.

Basin O, *or North Branch of the Hazleton Basin.*—As already intimated, the Big Coal seam extends no further in the basin N. of the Cranberry Ridge axis than its outcrop at Cranberry village, unless, indeed, it enters it W. of Long Run, as an insulated patch penetrating perhaps a short way into the Powell Lands; but at present the evidence is insufficient to establish even

this conjecture. The W. point of this basin is at the source of Stony Run north of the Horse Shoe Swamp, or some 4 miles W. of Cranberry. Here the basin seems to divide itself into two, one fork extending up Wolf Run, the other, and longer one, up Stony Run. North of the middle of this basin, and near the E. line of the Powell Lands, or the N.W. corner of the Kunkle Tract, two or three coal-beds have been carefully opened by shafting; one of them is alleged to have shown a thickness of 6 feet, and another of 8 feet of coal, and the dip is S. 30°. Other developments are now in progress.

The Main Hazleton Coal Basin.—Restricting our attention now to the Main Hazleton Basin, to the exclusion of its Eastern and Western prolongations and branches, we may state it to have an average width, from outcrop to outcrop of its lowest coal, of nearly seven-eighths of a mile, being narrowest at the Stockton collieries, and widest opposite Crystal Ridge.

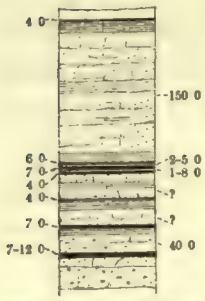


Fig. 212.—Coal Strata, Hazleton.

Of the lowest Coal-measures in this basin but few particulars present themselves claiming a permanent record here. There appear to be three coals underlying the Hazleton large seam. The *lowest* of these is usually the thickest and best in quality, though for the most part it is full of the bird's-eye fracture, and very rough. Near the Sugar Loaf Mine it has been proved 7 feet in thickness, outcropping at a gentle dip about 150 yards S. of the face of the conglomerate. Further W., and on the same N. side of the basin, it has been mined in a small gin-slope, exhibiting 11 feet of rough coal in three benches. Again, about 3 miles W. of Hazleton, it has been opened on the Kunkle Tract, in the N. branch of the Hazleton Basin, showing a thickness in the shaft of about 10 feet of rather rough coal. There it is close to the conglomerate, the dip being rather steep. On the S. side of this same basin it has been opened on a gentle N. dip, outcropping about 120 yards from the conglomerate, and showing the same thickness of 10 feet. Still further W., but in the S. or Tomhicken basin, it has been exposed by shafting, dipping N., and exhibiting a thickness of 15 feet, with three benches. Here the coal resembles somewhat that of the Hazleton bed. Yet further W., though still some 2 miles from the junction of South and Big Tomhicken, this coal proved, in a shaft on the N. slope of the Catawissa Ridge, to have a thickness of 9 (?) feet.

The *Second* coal ascending, or next in order, opened at the Laurel Hill Colliery, seems to possess there a thickness of 6 feet. It outcrops about 600 feet S. of the outcrop of the Big Coal, dipping at an angle of about 30°.

On the N. side of the basin, this coal outcrops N. of Hazleton in a well-marked bench about 1000 feet N. of the outcrop of the main bed. It has been reached by shafting in that neighbourhood near the Wilkesbarre Turnpike. This coal is usually from 5 to 7 feet in thickness, but it is generally a rough and bony coal.

The *Third* coal of the series, or that next beneath the great bed, outcrops on the N. side of the basin, at a gentle dip of 20°, about 500 feet from it. It also is indicated by a well-defined bench on the sides of the basin. This coal has been proved in but few places, but its usual thickness is known to be about 5 feet. In quality it is better than either of the two beds beneath it.

The *Fourth or Big Hazleton Coal Bed.*—The next in ascending order, the sole source of the mining wealth of the Hazleton Basin at the present time, is a complex mass, consisting of three

main seams or benches of coal. These, and the dividing-slates which make up the total mass, some 27 feet in thickness, exhibit in the Laurel Hill Colliery of the S. side of the basin about the following average dimensions and subdivisions :—

The lowest bench of coal is 5 feet thick, but only $2\frac{1}{2}$ or 3 feet of it are of prime quality, the remainder being rough bird's-eye coal.

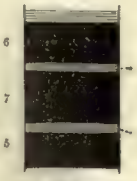


Fig. 213.—Big Coal of Hazleton—General Type.

The hard slate rock above this varies much in its thickness throughout the basin : it is thinnest on the N. side, as at Sugar Loaf and Hazleton No. 3 slope, but W. of Hazleton No. 1 slope it begins to enlarge, and 500 yards further it has swelled to 16 feet.

The Seven-feet bench consists of good coal, though one band of it is rather coarse ; usually it is of the best quality on the N. side of the basin. This bench is, however, remarkable for consistency throughout the different mines.

The division above the Seven-feet bench, called by the miners "the benches," is an alternation of coal, bony coal, and slate, but it includes in some places a sufficient amount of pure coal to admit of mining, yielding even $4\frac{1}{2}$ feet of coal, of a coarse quality.

The next or Six-feet bench has in some places a thickness of 8 feet, and in others not more than 3 or 4 feet. On the S. side of the basin, at Laurel Hill, this is a coarse coal, though marketable ; but in all the collieries on the N. side it is of excellent quality.

The top bench consists of slate and bone coal, with no marketable coal in it. Its average thickness is 4 or 5 feet. This is often left as the roof of the mine.

The immediately overlying rock is sometimes a rough sandy roof-slate 3 or 4 feet in thickness, and sometimes the coarse capping grey sandstone, without the intervening slate. This sandstone is a massive deposit many yards in thickness, and embraces, among its middle beds, some which are very pebbly or conglomeritic.

The *Fifth* coal, and uppermost in the basin, is a seam about 4 feet thick, lying at a considerable interval above the large bed. This, like the rest, is a White-Ash coal. It has been proved to approach very near to the surface in the centre of the basin, being lifted by an anticlinal undulation under the main street of the village of Hazleton, where its dips have been established in several wells and other excavations. The existence of this anticlinal is an intimation that the central or deeper tracts of the basin are not without important undulations.

HAZLETON.

The mines in the *Hazleton Basin* are as follows :—

Hazleton Slope No. 1 is sunk upon the Big Coal, dipping Southward 23°. Its length is 210 yards. From the foot of the slope, gangways are driven E. and W. upon the coal. In a similar manner, at higher levels, two gangways work out the coal. The extreme Eastern point reached in 1854 was 1100 yards : Westward the middle level was driven 900 yards. In the E. gangways the coal at times is somewhat soft and crushed. Between the lower benches of the Big Coal in this mine there are 2 feet of slate, which thickens up to 16 feet in the Western gangways, 500 yards from the slope.

Slope No. 3 of the Hazleton Company is situated on the N. side of the basin E. of Hazleton ; its length is 150 yards. The inclination near the surface is 23°, but it gradually steepens to 30°. Gangways are driven at two levels from this slope E. and W. Our measurements, representing

the thickness of the Big Coal, are taken between this mine and Slope No. 1. They are as follows :—

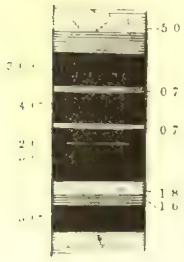


Fig. 214.—Big Coal, Hazleton.

		Feet.	Inches.
	Slate and Bone Coal,	5	0
Six-feet bench.—	Coal good,	3	6
	Black slate,	0	7
Poor Man's.—	Coal, fair quality,	4	0
	Slate,	0	7
Seven-feet bench	Coal, good,	2	0
	Coal, lower 10 inches, pyritous,	5	0
	Slate,	1	8
Four-feet bench	Coal, bony,	1	6
	Coal, good,	3	6

Sugar Loaf Slope, one mile E. of Hazleton; length 180 yards, and to be sunk 80 yards further. Two levels and gangways E. and W.—600 yards in the former direction, and 400 yards in the latter. The dip is about 28° S. The Big Coal retains its average dimensions.

On the S. side of the basin near Hazleton, the *Laurel Hill* Slope Mine, No. 2 of the Hazleton Company, is sunk 180 yards, at an inclination of 25° N. There are two levels, one 80 yards down, the other at the foot of the slope. The E. lower gangway sweeps round to the N., and turns W. to meet the W. gangways, which in like manner are deflected to run E. It thus appears that there is a small local basin, proved by the workings of this mine, which heads up E. and W. Its length is about 200 yards. The upper level gangway, going W., seems to be uninfluenced by the roll. It is 1¼ miles long, bearing S. 75° W. The breast of coal W. is 250 yards above this gangway; a counter-level was therefore needed in order to work off the coal. In this counter-level the coal was found to flatten W. of the road to Tamaqua, and it apparently arches over into a S. dip. The anticlinal thus indicated appears to expire to the W.

The *Crystal Ridge Slope* is situated S. of Hazleton upon the Big Coal, dipping S. 25° from a minor axis S. of that above alluded to. The basin is reached at 160 feet. This basin evidently rises in its course W., for the gangways in that direction incline for some distance. Coal is worked from the N. dips of this basin. These N. dips at first rise very rapidly from the basin, then grow flatter, and finally steepen at the outcrop. An upper level gangway is mined E. and W. from a point 50 yards down the slope of Crystal Ridge.

Cranberry Shaft, W. of Hazleton, is sunk 26 feet to the top of the Big Coal, and 40 feet to the gangway level. In driving the gangway W., a rock-fault was met between 600 and 700 yards from the shaft. The fault bears S.E. Coal was met again by going 30 feet through the fault. Its quality was found unimpaired. The dip in the gangway is S. at an angle of 20°; but in driving up the breasts some distance W. of the shaft the coal ran flat, and it was expected to turn over into a N. dip owing to the influence of an anticlinal. The coal-bed basins S. of the main gangway, and the branch gangways are deflected until they encounter the effects of a gentle roll, around which they again turn and follow their normal course W. A slope-mine enters upon the same great bed W. of the shaft to the level of the main gangway.

In the Hazleton Basin at Stockton, 2 miles E. of the village of Hazleton, are situated the mines of Packer, Carter, and Company.

The *Old Slope* No. 1 is sunk on the S. side of the basin upon the Big Coal bed. Its inclina-

tion, at first 45°, steepens to 58°. The slope length is 100 yards, and from it gangways are worked E. and W. to considerable distances. On the N. side of the Valley, Slope Mines Nos. 2 and 3 are dependent upon the same great bed, which retains its bulk and parting-slates as at Hazleton. In No. 2 the dip, at first 50°, flattens at the bottom to 30° or 35°, and in No. 3 it is 20°. In the same vicinity a water-level tunnel has been driven N. to the Big Coal, which is mined from it by gangways driven E. and W. The tunnel is 200 yards long. Before meeting the Big Seam two small beds of coal or coaly matter were struck, one at the mouth of the tunnel, the other 150 yards in. The dip in this mine is 20° S.

The New Horne Coal is on the small slope; the bed is 11 feet thick; it was worked for 7 feet, and the best bench of 4 feet was left beneath. On the lower bench was traced the same coal as on A. S. Roberts' land, 3 miles W.; it proved to be 10 feet thick, and good.

The Horne Coal is about 9 feet thick at Horne's; it is 100 feet S. of the turnpike. Mr Fenstermacher found it, and opened a coal 6 feet thick at Roberts', 3 miles W., which he regards as the same. The strike between it and the Four-feet Coal is similar, and the two benches showing the outcrops are nearly in a line: so the 4-feet is but an upper coal, probably the next adjacent.

LIMITS OF THE MAIN COAL-SEAM, AND THE COLLIERIES AT PRESENT ESTABLISHED ON IT IN THE HAZLETON BASIN.

Directing our attention now to the area occupied by the great coal-bed of the Hazleton Basin, we find that this has a length of from 5 to 5½ miles, and a maximum breadth W. of Hazleton of nearly three-fourths of a mile. East of Stockton, or Carter's Collieries, the two outcrops of the basin of this coal seem rapidly to approach each other, and to indicate its terminating at no great distance E., the extensive denudation of the Coal-measures in this part of the valley of Hazle Creek having tapered it off. From Carter's Slope No. 1, or the most Eastern working on the S. edge of the basin, the outcrop rapidly descends into the bed of the valley to meet the N. outcrop, gradually deflecting in the same manner, but precisely where they unite has never been ascertained. Tracing the S. outcrop W., it will be found to range in a nearly straight course, with a gentle undulation, influenced by the ravines which cut the N. slope of the hill against which it rests the whole way to the vicinity of Eagle Creek, a mile W. of the Crystal Ridge Mine. The N. outcrop, traced W. from Carter's newly-established mine, No. 3, observes likewise a very nearly straight direction till it approaches within a fourth of a mile of the Cranberry mining village. There, in the neighbourhood of the valley of Cranberry Creek, the upper strata have been extensively denuded, and the edge of this coal turns rapidly towards the S.W., to cross the creek in the direction of the Cranberry Mine Shaft. This coal, therefore, does not extend into the basin N. of the anticlinal axis of the Cranberry Ridge, but its N. outcrop, in its W. extension, belongs to the Southern Branch Basin, or the so-called Cranberry Basin. From the Cranberry Mines we may trace it therefore along the S. slope of the Cranberry Ridge to its W. termination, where it unites with the S. outcrop near the entrance of Eagle Creek into the valley.

Nine collieries are at present seated upon this valuable mass of coal. Three of these are on its S. outcrop—the Stockton Colliery, No. 1, belonging to Packer and Carter; the Laurel Hill Colliery, or No. 2 of the Hazleton Company, the W. gangways of which now extend for 1¼ miles W., passing far beyond the town of Hazleton; and, thirdly, the Crystal Ridge Colliery and Slope, working like the others, but descending S. into the local branch basin of the Crystal Ridge, the

property of the Cranberry Company. Five of the remaining six are seated on the N. outcrop, Carter's New Mine No. 3, opposite the Stockton Mine No 1, being the most Eastern; the Mine No. 2 of the same company, three-quarters of a mile W., being the next; the Sugar Loaf Mine, half a mile W. of this, the third; the Hazleton Company's Slope, No. 3, five-eighths of a mile still further W., the fourth; and the Hazleton Old Slope, No. 1, 1⅛ miles yet further, being the fifth.

The ninth and last to be enumerated is the Cranberry Colliery, seated near the actual outcrop, as already mentioned, but near the anticlinal axis of the Cranberry Ridge, and therefore more nearly in line with the centre of the Hazleton Basin than with either margin of it.

Dips.—The configuration of this basin, or the more central part of it embracing the large coal-bed, will be understood when we state that the average degree of dip N., along the S. outcrop, is about 25°, until we approach it E. end, where it is as steep as 45°. The N. outcrop of the same coal exhibits at the various collieries S. dips varying from 20° to 30°, except at Carter's Slope No. 2, where the outcrop shows a steepness of nearly 50°. The N. side of the basin appears to flatten in descending towards the synclinal centre of the valley, whereas the curve steepens, at least in the Stockton Colliery, on the S. side. It has been already intimated that the centre of the basin is more or less undulated: that this must be the case is manifest from the positions occupied by the several known anticlinal flexures which observe directions likely to carry them a greater or less distance into the interior of the basin, and evidence has already been cited of the presence of a saddle quite in the middle of the trough under the village of Hazleton. Upon no other hypothesis than this, of a somewhat flat but undulated synclinal bed, can we explain the absence of a considerable series of coal-seams, such as should overlie the great bed, if the marginal dips into the basin should continue to any great depth. There being but one upper coal-bed detected, is a strong intimation that the strata overlying the main coal-seam in the middle of the trough are comparatively thin.

I estimate the total area of the great Hazleton bed at about 1700 acres. The basin is remarkably destitute of faults, or any disturbances which cause a waste of the coal in mining, and with due care it is practicable to abstract at least five-sixths of all this coal from the basin. The seam yields of merchantable coal a thickness varying from 15 to 17 feet, equivalent to a net product, with good mining, of 20,000 tons to the acre, a proportion which implies an aggregate of marketable coal in the basin of about 34,000,000 of tons.

CHAPTER IV.

BLACK CREEK BASINS.

BIG BLACK CREEK BASIN, OR BASIN No. 4.

THE E. end of the large coal-field of Big Black Creek is penetrated from the E. by several parallel anticlinals, which subside W. within it.

ANTICLINALS P AND Q, AND BASINS *p*, *q*, AND *r*.

Two of these anticlinals, P and Q, are noticeable in that part of the basin which extends from near the Owl Hole westward to Fillmore. They subdivide the general basin into three subordinate but closely-connected troughs. The Southernmost of these, Basin *p*, appears to be narrow and short, not extending E. much beyond the Conyngham Road. The middle one, *q*, 1000 feet broad at the Fillmore Colliery, is the longest, heading E. within half a mile of the Owl Hole: this is Basin No. 3 of the Buck Mountain Company, who have newly opened a colliery in it by a shallow perpendicular shaft, sunk just in the synclinal axis at the point where a branch of Sandy Creek cuts off the upper strata, giving easier access to the coal.

The coal-bed at the new Buck Mountain Colliery, No. 3, consists of the following divisions: an upper bench, 9 feet in thickness, of merchantable coal, without slate; a middle bench, from 4 to 5 feet of good coal, rougher than the upper bench; a lower bench, 2 feet 6 inches of bony coal and slate.

The Northern basin *r*, shorter than the preceding, terminates E. very nearly opposite the Buck Mountain Company's shaft. It is much wider than the middle one, its N. outcrop being at the foot of the Southernmost high ridge of E. Buck Mountain. At Fillmore, and for some distance E. and W., the mean breadth of the basin is not more than half a mile.

Only one bed of coal has hitherto been proved in this division of the Black Creek Basin. It rests at a short interval above the main conglomerate, and is evidently the equivalent of the coal-bed of the two basins of the Buck Mountain Company's lands in East Pismire Hill. It is, in other words, the lowest productive coal of the series, and, for reasons already developed, cannot be the representative of the great Hazleton and Beaver Meadow Bed.

ANTICLINALS R, S, AND T, AND BASINS *s* AND *t*.

Three other anticlinals, N. of the preceding, enter the Coal-measures from the E., insulating two branches of the main Black Creek Basin between them, namely, *s* and *t*. Of the coal in these we know at present extremely little. Near the N. edge of the more Northern of these, or more than half a mile N.E. of Jeddo, or one-third of a mile E. of the ravine of Cross Creek, through the conglomerate ridge which bounds the basin, two shafts have been sunk in coal on the Jeddo Lands. The bed dips S. from 25° to 30°, and is in two branches, the upper one 6 feet thick, and the lower one 5 feet, with 3 feet of hard slate between them. Whether this is the lowermost, or Buck Mountain Coal-seam, or whether it is the Hazleton bed, is a question which must remain unsettled until the strata of this basin are more systematically exposed.

Big Black Creek Basin.—Between Jeddo and the Wilkesbarre Turnpike the Black Creek Basin appears to have an average breadth exceeding half a mile. Along its E. half it is somewhat wider than this, but from a mile E. of the road to the road itself, the area of the large coal gradually contracts, until the two outcrops unite at a short distance, it is believed, W. of the turnpike.

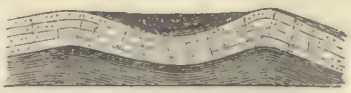


FIG. 215.—Black Creek Basin, E. of the Wilkesbarre Turnpike.

Extremely little is known of the contents of this basin. A large coal has been shafted just W. of the mouth of Cross Creek, on the N. side of Black Creek, dipping at the gentle angle of 10° N. Its thickness was not clearly ascertained. To which bed in the series this appertains,

we cannot at present ascertain. The only other point in the basin where a large coal-seam has been opened is on the lands of Siverey and Longstreth, a point about one mile E. of the Wilkesbarre Turnpike; this is on the N. side of the basin, the coal at its outcrop dipping 30° S. The bed here discovered is thick; it is believed to be the equivalent of the great Hazleton bed, and from the distance of its outcrop from that of the upper beds of the great conglomerate, I infer that it can be no other. Near the W. end of this basin, and on the N. side of the synclinal axis, a deep and expensive boring has been made just W. of the Wilkesbarre Turnpike in quest of the large coal-seam. It is immediately N. of the N. outcrop of a thick pebbly sandstone or Pea-conglomerate, supposed by the engineer to be the cap-rock of the great coal-bed, but which is in reality the overlying stratum to one of the lowest small coals, probably the second in the series. The boring failed to reach any coal, but was not deep.

There is a small detached basin *n* in the general synclinal belt, No. 4, extending as far W. as Barne's Run. This embraces the lower Coal-measures; it is pretty well ascertained to contain none of the large upper bed of Hazleton.

BASIN No. 5.—LITTLE BLACK CREEK BASIN.

Too little is known of the limits of the Coal-measures, and especially of the upper or Big bed in this basin, to authorise our saying much respecting it. It evidently forks into two branches, perhaps a couple of miles E. of the Wilkesbarre Road, by the intrusion of a bold axis, V., of conglomerate, which penetrates this synclinal belt from the E., between the two Northern spurs of the East Buck Mountain. This axis lifts the conglomerate both E. and W. of the road leading from the Buck Mountain Mines to Howey's Tavern, insulating from each other the two basins of the lower Coal-measures *v* and *w*, branches of the basin of Little Black Creek.

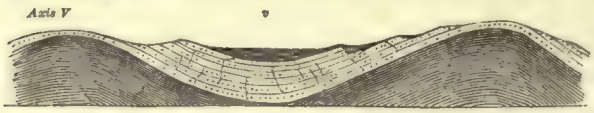


FIG. 216.—E. end of Little Black Creek Basin, Buck Mountain.

The large upper coal-bed has not been actually opened far to the E. of the Wilkesbarre Road, which is a long distance to the W. of where the basin forks. On the N. edge of the branch basin *v*, at a distance of a third of a mile E. from the road, a coal-bed, believed to be the lowest of the series, has indeed been proved. This point is designated on the Map as Roberts' Shaft. The outcrop is near to that of the conglomerate, and it shows a S. dip. At Balliot's Old Slope the Big Vein was wrought a few years ago upon its S. dip. The same large coal-bed has been opened about a fourth of a mile W. of the turnpike, upon its N. dip, and S. of the Little Black Creek. It there possesses the full dimensions of the great Hazleton bed, its total thickness being 27 feet.

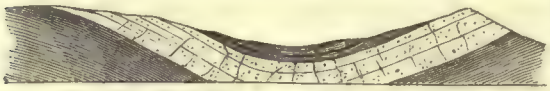


FIG. 217.—Buck Mountain, or Little Black Creek, E. of the Wilkesbarre Turnpike.

The W. limit of the large coal in this basin, according to those who have attempted to trace it by the external indication of its outcrops, is from 1 to 1½ miles W. of the Wilkesbarre Turnpike. At the turnpike the N. edge, or outcrop of the Big Coal, is S. of Little Black Creek.

FIG. 218.—Little and Big and Black Creek Basins, near the junction of the two branches of Black Creek.

The lower Coal-measures extend in this basin to the neighbourhood of the Berwick Turnpike, beyond which they have been swept away by the general denudation of the surface.

BASIN OF MAIN BLACK CREEK, OR BASIN No. 5 WEST.

Along the whole line of the Main Black Creek, from the mouth of Cranberry Creek westward to Roberts' Creek, there extends a synclinal belt of the Coal-measures; but whether these embrace any of the large upper bed of the region, has not yet been ascertained. From the mouth of Cranberry Creek to within 3 miles of the sudden turn N. of Black Creek, or a distance of 5½ miles, this strip of the Coal-measures is narrow, and apparently quite shallow; but at that place the belt rapidly widens, becoming more than half a mile broad; and it is quite possible that this division of the basin may contain some of the Big Coal. Crossing Black Creek near its great bend, the coal-basin, pursuing its course W., but gradually contracting in breadth, ascends the valley of Roberts' Creek, a distance, it is believed, of about one mile. Coal has been opened near the turn of Black Creek, both E. and W. of the stream, on the S. side of the basin, dipping about 20° N. Coal has likewise been opened further W. up the valley of Roberts' Creek.

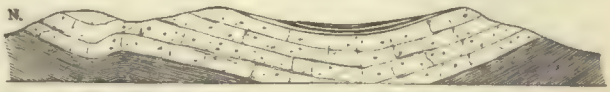


FIG. 219.—Buck Mountain west of Black Creek Gap.

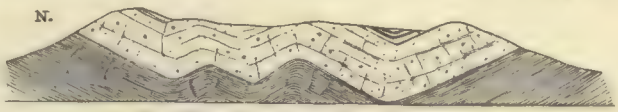


FIG. 220.—West End of Buck Mountain.

EAST GREEN MOUNTAIN BASINS, No. 6.

Basin No. 6, x.—Of the two basins already stated to exist in the general synclinal table-land of Green Mountain, the largest and most important is that of the W. half of the mountain. The E. extremity of this wide and regular coal-field is not more than one-fourth of a mile N.E. of Howey's Tavern. Its W. extremity is probably about half a mile E. of the W. terminating knob of the mountain; the whole basin, therefore, has a length of at least 2½ miles. Its central and widest portion is about half a mile broad. It seems to lie somewhat obliquely on the mountain, its S.E. margin approaching quite closely to the anticlinal belt of Red Shale at Howey's Tavern, and its Northern margin approximating quite closely to the N. edge of the table-land at the head of Hell-Kitchen Ravine, one of the few localities where any coal has been opened in it.

At this last-named spot a bed of coal, evidently a large one, has been mined to a small extent on Larkin's estate. Its outcrop is about 300 feet from that of the conglomerate. It dips very gently S., being indeed almost flat. The thickness of the coal here has not been fully proved, an upper bench being nearly washed away at the entrance of the drift. The only portion mined is a bench 7 feet thick, the upper bench crushing down upon this within the drift. Coal has likewise been opened and mined to a small extent by a gin near the S. edge of the basin, about 1 mile W. of Howey's. Here the prevailing dip is to the N. 25°. Both here and at the Hell-Kitchen Ravine the coal much resembles that of the great Hazleton bed, being of excellent quality.

The surface-features of this mountain-basin are remarkably smooth and regular, implying a relative absence of interior undulations or disturbances, and on the whole this promises to be a valuable coal-field.

Basin No. 6, *y.*—The other and smaller basin of East Green Mountain is situated about a mile N. of the White Haven Road leading E. from Howey's Tavern. This small trough of Coal-measures is seated on the N. verge of the table-land N. of the anticlinal undulation X, which divides it from the preceding coal-basin. It is believed by those who have examined it for coal, to be about three-fourths of a mile long, and about 1200 feet broad. Hitherto it has disclosed but one coal-bed, which at its outcrop, exposing coal and coal-dirt, measured in the trial-shaft about 8 feet in thickness. It dips gently S., the shaft being on the N. side of the basin, and about 150 yards from the outcrop of the conglomerate. It would appear to be the lowest, and perhaps the only one, in the basin.

FIG. 221.—Section of East Green Mountain Basin.

BASIN No. 7, OR THAT OF McCAULEY MOUNTAIN.

There is a small patch of Coal-measures on the summit of McCauley Mountain, an insulated outlying synclinal hill, situated about 9 miles E. of Catawissa. The length of the strip of productive coal-strata in this elevated little trough is apparently about 2 miles, and its breadth from a fourth to a third of a mile. There are two large beds of coal here, the equivalents in all probability of some of the thick seams of the Lower White-Ash group of the Shamokin and Nanticoke coal-fields. This long-neglected little basin has been recently connected with the market by a short branch-railroad from the Catawissa Road.

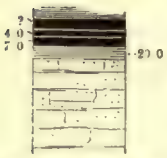


FIG. 222.—Coal-bed of McCauley's Mt.

FIG. 223.—One of the Cave Workings in the South Mine of the Great Lehigh Summit Coal Seam: height about 40 feet.

DIVISION III.

WESTERN MIDDLE COAL-FIELD.

CHAPTER I.

MAHANOY COAL-REGION.

GENERAL STRUCTURE AND TOPOGRAPHY.

For the sake of clearness in the classification and definition of the several parts of the extensive and complicated Western Middle Coal Region, I propose to call this, in general terms, the Mahanoy-Shamokin Basin or Coal-field, as being one great synclinal district of coal-bearing rocks, almost entirely insulated, or surrounded by valleys of the Umbral red shale. It is essentially one great coal-field, there being no belt of any other rocks than the coal-conglomerate penetrating into or subdividing it. Being almost exclusively watered by the Mahanoy and Shamokin creeks, it is best designated by the united names of these two streams.

This whole coal-field is partially but not entirely separated into two compound or undulated basins of productive Coal-measures by the elevated anticlinal mountain-ridge called Locust Mountain, which, in the central and Western portions of its length, exposes along its crest a narrow belt of the Seral conglomerate, which there divides the true coal-bearing rocks of the Western half of the Mahanoy Valley from the same strata of the Eastern half of the Shamokin Basin.

The proper designation for all that part of the coal-field which is embraced between the head-waters of the Quakake and the Little Schuylkill on the E., and the W. source of Locust Run of Shamokin Creek on the W., is the Mahanoy Basin ; for, except in its extreme Eastern spurs, and at its extreme Western end, it is everywhere drained by the tributaries of the Mahanoy. From its Eastern spurs to Big Mine it is bounded on the S. by the Mahanoy and Broad mountains, and on the N. by the Big or Head Mountain, and from Big Mine Run to Locust Knob, the Western termination of the basin, its Southern boundary is still the Mahanoy Mountain, whilst its Northern is now the crest of the Locust Mountain. It should be distinctly understood, however, that the Locust Mountain is not continuous with the Big Mountain, and therefore does not completely insulate this basin from the Southern branch of the proper Shamokin Basin, the two being really united by the subsidence E. of the Locust Mountain axis, at the head-waters of Big Mine Run.

The Shamokin Basin is bounded on the S. by the Locust Mountain crest from Big Mine Run to Locust Knob, and thence Westward to the extremity of the basin by what should properly

be called the Locust Mountain, but is frequently entitled the Mahanoy Mountain. On the N. the basin is limited by the monoclinal crest of the Thick or Shamokin Mountain.

The W. end of this basin is watered by the sources of Zerbe's Run, which falls into the Mahanoy in the Red Shale Valley outside of the coal-field, and not into the Shamokin. At the head-waters of Big Mine Run, this basin, as already intimated, is actually connected with that

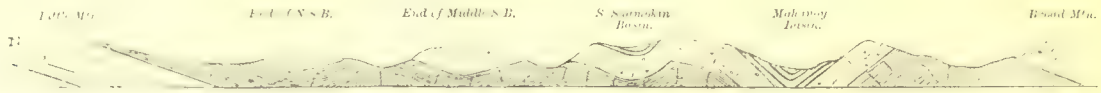


Fig. 224.—General Section from Little Mountain to Broad Mountain, across the Shamokin and Mahanoy Basins E. of Big Mine Run.

of the Mahanoy, by the declension Eastward of the Locust Mountain anticlinal, which allows the Coal-measures an uninterrupted extension by a narrow belt from the one field into the other.

MAHANOY AND SHAMOKIN COAL-REGION.

In our general description of the structure of the anthracite region, the external boundaries of the Mahanoy and Shamokin coal-region have been already defined, and the great anticlinals of the country indicated, which elevate the belts of Umbral red shale outside of it, and impart to the whole coal-field its general trough-like configuration.

This extensive coal-region is not, however, a simple synclinal trough, but possesses a quite complicated structure from the presence within it of a number of anticlinal and synclinal undulations. Upon a correct knowledge of these mainly depend the successful development and economical mining of the coal contained within the strata ; and I therefore proceed to a systematic description of these flexures as the groundwork of my whole statement of the distribution of the several coal-beds.

In tracing the anticlinal and synclinal lines which define respectively the saddles and troughs of the district, I will observe the order already adopted for the Pottsville Basin, commencing, that is, with the most Southern axes, and describing each axis in its course from E. to W. While tracing the anticlinals or saddles, due mention will be made of the *lowest* coals which they elevate to the surface at successive points, and in specifying the synclinals or basins embraced between the saddles, similar allusion will be made to the highest coal-beds included within these troughs, or which have escaped denudation. The reader should consult the 3d Section on Plate IV.

DETAILED DESCRIPTION OF THE ANTICLINAL AND SYNCLINAL FLEXURES.

Properly regarded, the Mahanoy and Shamokin coal-field commences at the E., in the high synclinal knob or spur called the Head Mountain, which juts forward into the Red Shale Valley of the Quakake. Expanding into a wide and elevated plateau, it ranges Westward, and about 4 miles from its E. extremity throws Northward a broad flat anticlinal platform, to connect itself with the E. crest of the Spring Mountain. Here the plateau across which the Hazleton and Tamaqua Turnpike passes to descend through Lindner's Gap, has a width of nearly a mile and a half. From Lindner's Gap the table-land, contracted to an average width of one mile, ranges on for about 3 miles to the head of the deep anticlinal

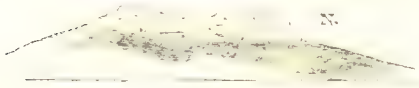


Fig. 225. East End of Head Mountain, looking W.

cove of red shale which lies E. of the source of Little Pine Creek. Here the whole basin is suddenly enlarged by the addition of all that portion which embraces the three E. tributaries of the Mahanoy. This expansion of the general basin arises from the introduction, going Westward, of the whole synclinal trough embraced between the anticlinal of the Red Shale Cove, and the monoclinal crest of the proper Mahanoy Mountain. That section of the basin which extends from the Red Shale Cove here mentioned, to the region of the W. head of the cove of the Hassasock, includes therefore the prolongation of the table-land of the Head Mountain, here known as the Big or Shamokin Mountain, and also the E. end of the true synclinal valley of the Mahanoy. These two divisions are connected by a wide tract of nearly horizontal strata, extending from the head of the Red Shale Cove to the mouth of the North Mahanoy, a belt which may be regarded as produced by the dying-away of the anticlinal of the Red Shale Cove at the one end, and of that of the Bear Ridge at the other. It does not appear that the E. anticlinal actually arches the strata to any great distance Westward of the cove, for at the sources of Pine Creek, and the North Mahanoy, the rocks are nearly horizontal; nor does it appear that the Bear Ridge axis is prolonged Eastward as a true wave to any extent beyond the gap of the North Mahanoy, yet the effect of these two anticlinals, nearly coincident in line, is to lift and flatten the lower Coal-measures along the whole course of the North Mahanoy stream, and the central ridge which bounds it on the S.

Anticlinal of Head and Big Mountain, No. 1.—The Big Mountain, with its E. prolongation, the Head Mountain, carries an anticlinal undulation centrally throughout nearly its whole course E. from the Middleport and Catawissa Road, and it is to the presence of this line of uplift that the mountain owes its elevation and table-land form.

The topographical features and the dips of the strata alike indicate that the undulation passes out of the plateau Eastward through its S. margin, at a point about 2 miles E. of the Tamaqua and Hazleton Turnpike—a conspicuous knob in the side of the mountain, indicating the point of emergence where it enters the Red Shale Valley to the S. of the Head Mountain. From this point Westward the axis grows progressively sharper as far as the gorge of the East Branch of the creek down which the turnpike passes, and beyond this it seems gradually to flatten down again in its dips as it ranges on to the district opposite the North Mahanoy. In this latter neighbourhood it manifests itself in the high and regularly-arched form of the conspicuous mountain-knob which extends for about a mile to the S.E. of the deep cove or hollow in the N. side of Big Mountain. The same anticlinal is visible at the crossing of the Middleport and Catawissa Road, and may be traced indeed along the high broad summit of the Big Mountain for some miles still further Westward.

Coal Basins of Head and Big Mountain, Nos. 1 *and* 2.—The nearly central anticlinal of the Head and Big Mountain divides two small coal-basins which occupy a part of the summit of the plateau in the vicinity of Lindner's Gap. The whole synclinal table-land being here more sharply undulated by the steeper flexure of this anticlinal than further Westward, the two troughs which bound the saddle, one on the S., the other on the N., contain here a moderate thickness of the lower Coal-measures. But the flattening and lifting of the anticlinal in its course Westward appears to throw out these coal-rocks ere we reach the vicinity of the Red Shale Cove north of Pine Creek. What the exact limits E. and W. of the productive Coal-measures may be in either of these basins, it is impossible, in the present unopened condition of the district, to

define. The more Southern basin, or that just N. of Lindner's Gap, is evidently the narrowest, but being bounded by steeper dips than the other, may possibly contain two or three of the lowest coal-seams. It does not seem probable, however, that this trough contains any Coal-measures whatever beyond a mile or so E. of the gap, nor is it likely that these rocks range Westward of the gap more than 1 or 2 miles.

FIG. 226.—Head Mountain, S.W. Side of Lindner's Gap.
Note.—The Cut does not represent sufficiently steep dips in the S. Basin.

In regard to the extent of the Coal-measures in the N. trough, or that which terminates in the knob of the Head Mountain, our information is equally vague. It is probable that here the Coal-measures extend considerably further Eastward than in the narrower basin to the S. of it, but it must be observed that in this basin the dips are gentle, and the whole trough of the coal-bearing rocks is therefore necessarily very shallow.

An extensive denudation of the Coal-measures in the vicinity of Lindner's Gap has contributed to reduce their depth. The ready outlet afforded by the breach of the Southern Mountain, at this place, to the denuding currents which have swept over the region, has permitted them to excavate a large amount of the coal strata, which are everywhere softer than the conglomerates that support and confine them. The same denuding action appears to have succeeded in carrying off the entire mass of the Coal-measures from nearly every other part of the Big Mountain, where the flatness of the undulations has given the waters a grasp upon the upper strata; for it is almost an invariable rule, that our high mountain table-lands contain but little coal, except in those troughs where a considerable steepness of dip or depth in the synclinal flexure has served to protect the upper or exposed coal-formation between the less destructible mountain-barriers of conglomerate. In confirmation of this statement of the general removal of denudation of the Coal-measures from the table-land of the Big Mountain, it is only necessary to state that we find nothing but the upper beds of the Seral conglomerate across the whole breadth of that plateau, either on the Tamaqua and Catawissa Road, the Middleport and Catawissa Road, the Newcastle and Catawissa Road, or, indeed, over any part of the mountain-summit between them.

BEAR RIDGE ANTICLINAL, AND THE SOUTH BASIN OF THE MAHANOY SOUTH OF IT.

Axis No. 2.—The axis of Bear Ridge first conspicuously displays itself in a fine arch E. of Westhouse Run, or about one mile W. of Faust's Tavern, and N. of the Mahanoy. It ranges thence with a steadily-increasing amount of flexure along the summit of the Bear Ridge, crossing the ravines of Westhouse Run, and the stream next W. of it. From this latter stream to the W. end of the ridge near Girardville, the anticlinal axis ranges along the N. slope of the ridge, a little below its sharp and rugged crests, throughout nearly all this part of its course. The flexure is very steep, or almost perpendicular, on the N. side of the axis, the main summit of the ridge being everywhere composed of moderately-inclined South-dipping conglomerates of the lowest Coal-measures, until we approach its W. extremity, where the S. dips likewise become very steep. The annexed cut, from a sketch taken about half a mile E. of the ridge, will serve to exhibit the

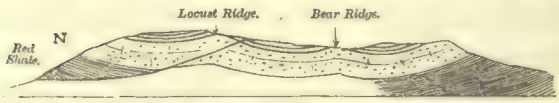


FIG. 227.—Mahanoy Basin at Eastern Origin of Bear Ridge Axis.
(The Dips are shown too flat.)

FIG. 228.—Broken Anticlinal Crest of Bear Ridge, half a mile E. of the Ridge.

abruptness of the anticlinal flexure, and the rugged character of the crest, resulting from so sharp a change of the dip.

Axis No. 3.—An important anticlinal belt traverses the entire length of the general Mahanoy and Shamokin coal-field, from the Red Shale Cove, which is near the head of Pine Creek, to the vicinity of Ashland. As already intimated, it does not actually arch the strata between the Red Shale Cove and the mouth of the North Mahanoy, but merely lifts and flattens the rocks which support the productive Coal-measures ; nor is it at all certain that the anticlinal axis of the cove is strictly in line with that which originates near the mouth of the North Mahanoy, and runs Westward at least as far as Westhouse Run, yet we may safely view the two, and the flat region between them, as constituting one anticlinal belt bounding the proper coal-basin of the Mahanoy on the N.

The rise of the anticlinal just W. of the mouth of the North Mahanoy causes the commencement of the basin of the Coal-measures north of that axis, and, at the foot of the Big Mountain, makes its productive coal strata extend Eastward in this second trough as far as Coal Run, a small tributary of the North Mahanoy. It is here that a bed of coal, 10 feet in thickness, has for some years been superficially mined on the lands of Mr C. Loeser, of Schuylkill County. But Eastward of Coal Run this basin seems to expire, any Coal-measures that it once contained having been washed out in the denudation which made the valley of the North Mahanoy. How far to the Westward this axis No. 2, and the coal-basin to the S. of it, may extend, we cannot now determine.

FIG. 229.—Section W. of Mouth of North Mahanoy, looking W.

In the vicinity of Faust's Tavern there occur on the flanks of the basin of the South Mahanoy at least three beds of coal, the lowest in the series. One of them is perhaps the equivalent of Loeser's large seam ; but we have no evidence of the presence so far Eastward in the basin of the great bed of the East Boston Basin, the equivalent apparently of the so-called Jugular Vein of the neighbourhood of Ashland. Nearly opposite the centre of the East Boston Basin, or about 2 miles W. of Faust's, and rather low on the N. slope of the Mahanoy, which is here called the Broad Mountain, two beds of coal have been opened by experimental shafting. The uppermost of these, or that nearest the base of the mountain, is stated to be 20 feet thick ; it is, therefore, probably the equivalent of the large New Boston bed, the distance between their outcrops not exceeding about 1 mile ; the other, or lower seam, is said to have shown in the shaft a thickness of from 7 to 9 feet. They are about 30 yards asunder on the outcrop.

FIG. 230.—Section of East End of the Mahanoy Coal-field.
(The S. and middle N. dips are too gentle.)

COAL-MEASURES IN BEAR RIDGE.

It is obvious that the anticlinal of Bear Ridge elevates very low strata in the productive Coal-measures, if it does not, indeed, lift to the surface in the district of its maximum rise the subjacent Seral conglomerates. In the Girard Tunnel it would seem that the upper beds of coarse Seral conglomerate do rise to the level of the

FIG. 231.—Section at the Bear Ridge Tunnel.

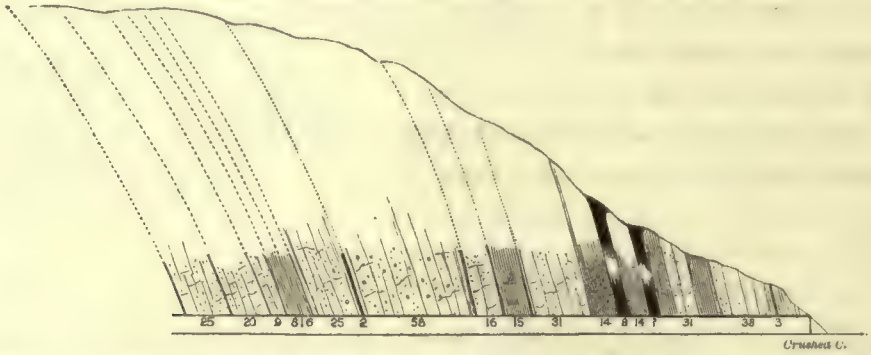
tunnel, and we find the same rocks on the crest of the ridge in several places between this point and its W. knob. The flanks of the ridge, however, support some of the lower coal-seams.

The anticlinal axis of the Bear Ridge does not cease with the termination of the ridge itself near Girardville, but may be traced Westward through the valley of the Mahanoy. We may, indeed, recognise indications of this axis at several points on the Old Pottsville and Danville Railroad, as at Girardville; and again, one mile W. of it, and even still further W., near Big Mine Run. W. of this last-named locality we may detect at one point a gentle N. dip of the Coal-measures, and yet further Westward, an extent of horizontal bedding which seems to imply the final dying-down of this extensive anticlinal. It is possible that these last phenomena do not belong to the Bear Ridge, but to some other more trivial one, yet they are so nearly in its line of prolongation Westward as to justify us in ascribing them to it. While it thus commences at the sources of the Mahanoy, in strata below any productive coal-seams, here, at its W. extremity, near Ashland, it affects some of the highest of the Coal-measures of the Mahanoy Basin, the bed of which it does not arch, but merely flattens.

FIG. 232.—Western Origin of Bear Ridge Axis.

Basin No. 3—the Mahanoy Basin proper, or the South Mahanoy Basin.—The basin or synclinal valley of the Mahanoy, bounded on the N. by the anticlinal of Bear Ridge, which we have just been tracing, and on the S. by the monoclinal crest of the Eastern Mahanoy Mountain, by the N. brow of Broad Mountain, and Westward of this by the crest of the proper Mahanoy Mountain, commences at the E. in the sharp synclinal knob lying between Pine Creek and the Red Shale Cove north of it. The gorge of Pine Creek reveals distinctly its synclinal structure, but discloses no Coal-measures so far Eastward in the trough. Passing Westward down the symmetrical spoon-shaped valley of the South Mahanoy, we detect in the terraced features of both the Mahanoy Mountain and the middle ridge of the basin the topographical indications of the lower coal-beds. Opposite Faust's Tavern, on the Middleport and Catawissa Road, the productive Coal-measures rise on the N. slope of the Little Mahanoy Mountain to an elevation of nearly 300 feet above the South Branch of Mahanoy, and their upper margin ranges nearly level from this point Eastward along the flank of the mountain, preserving a line about

FIG. 233.—Bear Ridge Tunnel, Mahanoy Basin, looking E.—1 *inch* = 100 *feet*.



half-way between the stream in the bed of the valley and the N. edge of the mountain summit. By the rise of the basin, this nearly level line gradually approaches the foot of the mountain, until it turns to constitute the extreme Eastern end of the basin of the coal-rocks. This will be found to be somewhere within or just E. of the Paul Hannah Tract of the Girard Lands, and but a short distance W. of the extreme head of the South Branch of the Mahanoy. The N. line

of the basin may be traced from this point nearly due Westward to the mouth of the North Mahanoy, and thence Westward a little S. along the summit of Bear Ridge.

Axis No. 4—*Shenandoah Axis.*—A third anticlinal axis is traceable through the interior of the Mahanoy Coal-field, commencing at the S. foot of the Big Mountain, E. of Coal Run, and terminating, so far as we are able to ascertain, a little W. of Big Mine Run, near Ashland. It is faintly visible N. of the North Mahanoy and on the Middleport and Catawissa Road. Ranging Westward, it passes along the crest of the ridge, the S. slope of which contains the source of Westhouse Run, and crossing the next stream, it follows the same ridge prolonged to where this is cut by the Shenandoah, south of Patrick Kaley's house, on the Newcastle and Catawissa Road. The anticlinal ridge, which, E. of this intersection, bounds the Shenandoah Creek on the S. after being cut by it, forms the N. boundary of the valley of that stream to its junction with the Mahanoy. The crest of this ridge, carrying the axis, passes about three-fourths of a mile N. of Girardville, and about the same distance N. of the mouth of Big Mine Run. In this neighbourhood it is the South-bounding ridge of the valley of the East Branch of Big Mine Run. This arch is not exhibited far to the Westward of the main Big Mine Run, its last appearance being recognised in a coal-shaft on a vein of slaty coal which just saddles the axis. It probably expires before reaching the Catawissa Road, its only effect there being a lifting of the table-land which lies S. of the main crest of Locust Mountain. Throughout its range, from the Middleport and Catawissa to the Ashland and Catawissa Road, it traverses a wild region entirely undeveloped, and it is impossible to specify the portion of the Coal-measures brought up to the surface along the crest of the wave; we only know that at its E. extremity it lies N. of the margin of any productive Coal-measures, and in the vicinity of Patrick Kaley's, on the Shenandoah, the Coal-measures saddle the axis, and on Big Mine Run it brings to view the strata which lie next below the great Mammoth coal-seam.

Basin No. 4.—We are equally at a loss to define the part of the coal series embraced within the basin which lies next S. of the anticlinal No. 3, which we have just been tracing; we can merely say, that at its E. extremity, near Coal Run, it contains Loeser's Ten-feet Coal low in the White-Ash measures; and that near its W. end, where Big Mine Run intersects it, it includes the Jugular and probably the Mammoth seams. In the intermediate tract, especially that of the valley of the Shenandoah, this basin is almost certainly deeper than towards either extremity; and if the axis No. 2 expires, as we have reason to think it does, before reaching the Shenandoah, this basin, here bounded on the S. by the Bear Ridge anticlinal, must be greatly deeper, and supplied with a far thicker series of Coal-measures. The determination of the W. limit of the feeble intermediate axis No. 2 will, therefore, be a point of much importance in any future explorations and estimates of the extent of coal in this part of the Mahanoy coal-field, now in chief part the property of the city of Philadelphia. Although the anticlinal axis No. 3 bounding this basin ranges nearly in a line with the great anticlinal of the crest of Locust Mountain, it would seem not to be continuous with it, but at Big Mine Run and further E. to lie nearly one-third of a mile to the S. of it. It is thus that axis No. 3 lifts and flattens the South-dipping strata of the S. flank of Locust Mountain, on the Ashland and Catawissa Road. (See Section, Plate IV.)

On Big Mine Run the belt S. of the anticlinal No. 3 contains two or three subordinate anticlinal undulations, at least two of which are recognisable near the Catawissa Road in the vicinity of Repplier's Tunnel.

Anticlinal Axis No. 5, or that of Ashland.—The next anticlinal is one of much importance in the structure of the Mahanoy Coal-field. It appears to originate somewhere between the Shenandoah and Big Mine Run, and to terminate Westward not far to the W. of the Old Minersville Road, towards the head of the general basin bounded by the Mahanoy and Locust Mountains. From Big Mine Run to the Minersville and Shamokin Road, this line of anticlinal flexure follows very nearly the crest of the middle ridge of the valley of the Mahanoy and Locust Mountains, or that which passes just N. of Ashland. This ridge possesses considerable breadth and elevation the whole way from Big Mine Run to Big Run, beyond the W. branch of which it rapidly declines. Throughout the chief part of its course the flexure is sharply folded with more or less inversion of the N. side of the wave ; and there is good reason to suppose, as an inspection of our Section along Little Mine Run will show, that in some places the abruptness of the folding has resulted in an actual dislocation or fault. The folded form of the axis is clearly proved by the sections on Little Mine Run and on Locust Run at the Catawissa Road, and is finely exposed to view in an arch of the strata at the intersection of the ridge by Big Run further Westward. It assumes the character of a depressed normal arch when it reaches the Old Minersville Road. How it terminates to the Eastward we are not at present able to say.

If we view the subordinate undulations which, from Big Mine Run to Big Run, everywhere follow the N. side of this inverted flexure, we may regard the whole belt, between the folded axis and the synclinal axis at the foot of Locust Mountain, as pertaining to the inverted side of a completely-undulated and greatly-compressed wave. Viewed in this light, the structure of the Mahanoy and Locust Mountain basin, as exhibited in our several sections, will be more readily understood. Let us now pass to a description of this complex basin, and to the explanation of the sections through which we design to illustrate what is at present ascertainable respecting the Coal-measures which it includes, and the undulations which disturb them.

BASINS BETWEEN THE MAHANOY AND LOCUST MOUNTAINS.

Basin No. 5, or Ashland Basin south of Anticlinal No. 5.—This interesting and very valuable division of the Mahanoy coal-field is in part a prolongation of that trough, in the strata which we have styled the Mahanoy Basin proper, but which, ceasing with the cessation of the Bear Ridge anticlinal, expands itself into this.

From Big Mine Run westward, even to the junction of the Mahanoy and Shamokin mountains, or more strictly, to the Western end of the Ashland folded anticlinal, this Ashland basin has the structure of an almost perfectly regular trough. Its rocks rise from a central synclinal line or axis, where they seem to be nearly horizontal towards either side of the valley, with an almost symmetrical inclination ; those on the S. side ascending into the N. flank of the Mahanoy Mountain, and those on the N. side into the S. slope and crest of the Ashland or Middle Ridge. The only departure from a strictly symmetrical structure is in the greater general steepness of the dip along the Southern, compared with that along the Western side of the basin, for the average inclination of the coal-beds and other strata in the Mahanoy Mountain is about 60°, while the opposite or S. dips, on the flank and at the foot of the Middle Ridge, does not much exceed 40°. This steepness in the N. dip in the Mahanoy Mountain prevails to the Western end of the whole coal-field, while the Southern inclination in the Middle Ridge gradually subsides to horizontality, as the axis of this ridge dies away Westward.

Two watersheds, or summits of drainage, occur in the length of this Ashland basin; they are not connected apparently with any upheavals of the strata, but are merely the results of denudation. The more Eastern one lies about midway between the Mahanoy and Big Run gaps, while the other is nearly midway between the Big Run and Locust gaps, the latter watershed being not far from the Western end of the Middle Ridge. The bed of the valley here is nearly level with the summit of that anticlinal range, and the entire surface of the basin, therefore, from mountain to mountain, is much elevated. Connected with these features there will probably be found a somewhat increased thickness or depth of Coal-measures in both instances; in the case of the watershed near Ashland, by a piling-up of the strata in the middle of the basin, and in that of the summit between Big Creek and Locust gaps by a similar addition of undenuded coals, assisted by the subsidence of the anticlinal flexure which elsewhere lifts all but the lowest measures from out of the centre of the coal-field.

Basin No. 6, or that of the S. Side of Locust Mountain.—Viewing this somewhat undulated synclinal belt as commencing somewhere in the vicinity of Big Mine Run, and as coalescing Westward at the point of subsidence of the folded anticlinal S. of it with the Ashland Basin, we may observe, from an inspection of the sections along Big Mine, Little Mine, Locust and Big runs, that towards its Eastern end is an elevated and much-disturbed tract of the lower Coal-measures; and this condition of things continues until we pass some distance Westward of Locust Run, the undulations occupying nearly the whole breadth of the belt between the folded anticlinal of the Middle Ridge and the normal axis of Locust Mountain; but as we approach the head-waters of Big Run, the plications and undulations no longer extend as far Northward across the basin, but become confined to its S. side, showing that they are not in reality undulations on the S. leg of the Locust Mountain arch, but are secondary disturbances connected with the great fold of the Middle Ridge. Contributing to this change in the structure of this disturbed belt, is a progressive cessation Westward of the more Northern of the smaller anticlinals which lie within it. First, the Shenandoah axis, or that next adjacent to the anticlinal crest of the Locust Mountain, expires a little W. of the Big Mine Run. In the next place, a smaller axis, made apparent in some shaftings near Big Mine Run, ceases at Locust Run, being detected there in Repplier's Tunnel, under features which show it to be fast expiring. A third subordinate saddle, visible on Big Mine Run just N. of the mine in the lower Big Coal bed, is, from evidence derived from shafting near the Catawissa Road, seen to be there subsiding, nor does it appear to pass far to the Westward of the ravine of Locust Run.

Not one of these three undulations S. of the Locust Mountain axis reaches the centre turnpike, where only a S. dip occurs from the summit to the base of the mountain. It is to the presence Eastward of these anticlinal waves or uplifts that we must impute the general rising in that direction along this belt of the lower Coal-measures, and the general elevation of the surface S. of the true flank of the Locust Mountain; and we must ascribe their absence Westward to the deepening of the valley between the mountain and the central ridge. Connected with this deepening there is doubtless a general deepening of the synclinal trough, or, in other words, an accumulation of Coal-measures admitting a greater number of coal-seams: this condition prevails to the Westward, until the general rising of the bottom of the whole

double synclinal trough, indicated in the drawing together of the Locust and Mahanoy mountains, counteracts it, and finally shoals out the Coal-measures.

Along the S. side of the synclinal belt which we are considering, there ranges, connected with the inversion of the N. side of the folded anticlinal of the Middle Ridge, a compressed or folded basin, traceable from Little Mine Run to Big Run, and perhaps ultimately still further in both directions. While the South-dipping rocks of the N. side of this narrow trough decline at an angle seldom exceeding 45°, the same beds, where they are overturned to form its S. side, lean past the perpendicular, at angles as low as 55°, and in some instances lower than 50°. This extreme degree of inversion is visible in two or three of the drifts on the E. side of Big Run. On Big Run this folded synclinal exhibits less regularity than belongs to it on the Little Mine Run east of Ashland. An inspection of our sections will show that at Big Run the S. side of the basin, or, what is the same thing, the N. flank of the inverted anticlinal, is excessively disturbed and thrown into a succession of folds, in at least two of which there is visible an overlap of the strata upon themselves.

COAL-BEDS IN THE COAL-FIELD BETWEEN THE MAHANOY AND LOCUST MOUNTAINS.

(Consult Section on Catawissa Road and Ashland Gap.)

Mahanoy Gap.—The water-gap of the Mahanoy, in the mountain S. of Ashland, affords an excellent opportunity for measuring the thicknesses of all the strata, from the upper members of the Umbral series to the middle Coal-measures, and for determining the order of superposition of many of the coal-seams, and their several thicknesses. The mountain being here cleft to its base, and furnishing a great slant length, or, in miners' language, a high breast on the lower coal-beds, this spot is destined to become the scene of active mining operations ; and as a preliminary to these, the coals have been systematically opened by a series of experimental shafts, and by several drifts penetrating the end of the mountain, forming the W. side of the notch, at an elevation a little above the stream.

Defining the several strata, as usual, in ascending order, the first mass we shall specially note is the Seral conglomerate.

Seral Conglomerate.—Understanding by this term the coarse unproductive portion of the Coal-measures, which, under the form of a thick succession of massive beds of nut and egg-sized conglomerates and pebbly sandstones, forms the floor of the lowest productive or even notable seams of anthracite, we may define it as here including but a comparatively small amount of sandstone, and as consisting mainly of beds of silicious pebbles of the full average coarseness. The thickness of this mass is about 600 feet, measuring it from the uppermost layer of Red Shale to the bottom of the first bed of coal.

Alternating with the upper portion of the Umbral series, occur five or six massive strata of grey silicious conglomerate and pebbly sandstones, in nearly equal thickness with the beds of Red Shale which separate them. These passage-beds, which mark the first invasion of the currents transporting the pebbly and sandy materials of the Seral Coal-measures, occupy, with the interposed layers of Red Shale—the last depositions of the tranquil waters thus invaded—a thickness of not less than another 600 feet.

First or Lowest Coal, No. I. of the Ashland Series.—The lowest coal is no more than 18 or 20 inches in thickness, nor does the seam contain this much of pure coal.

To it succeeds a massive bed of conglomerate, and another of sandstone, having an aggregate thickness of not less than 300 feet.

Coal No. II.—Upon this rests the second coal, impure and slaty, appearing to be 5 feet thick at its outcrop.

Between Coal No. II. and the next occurs a body of coarse grey sandstones, in thickness about 100 feet.

Coal No. III.—This third coal of the gap has been supposed to be the so-called Jugular Vein, of enormous thickness in the Mine Hill Basin. Here, at the water-level of the gap, it is believed to have a diameter of only 5 feet. Higher towards the summit of the mountain, and Westward along its N. crest, a coal, under the normal size of the Jugular, occurs, measuring as much as 28 feet, including in this thickness not more than 2 or 3 feet of slate, and 2 or 3 feet of impure or bony coal; but it is a different coal from No. III., being in reality, as our Section on Plate IV. shows, Coal VI. or the so-called Mammoth bed.

Above this 5-feet vein lies a Nut and Pea-conglomerate exceeding 150 feet in thickness.

Coal No. IV.—A small seam about 3 feet thick succeeds the Pea-conglomerate.

Sandstone and arenaceous slates, in thickness about 50 feet, now intervene between Coal No. IV. and the next coal-bed.

Coal No. V.—The fifth seam is likewise a very thin one, being only a foot or two thick.

A thickness of about 30 feet separates the Little Coal No. V. from the Great Mammoth Seam.

Coal No. VI.—This great bed, called the Mammoth Vein, in the Ashland Basin, measures at this place about 25 feet. It consists of three main benches of coal, insulated from each other by two dividing-slates.

About 120 feet of rock, chiefly coarse sandstone and Pea-conglomerate, divide the Mammoth bed from the next overlying coal.

Coal No. VII.—This is called the Six-feet Coal bed, but it usually contains not more than 4½ feet of coal. It includes two benches.

Succeeding the Coal No. VII. is a mass of Pea-conglomerate and sandstone about 160 feet in thickness, in which, at a depth below the next coal-bed of some 40 feet, occurs a stratum of shale, imbedding balls of iron ore.

Coal No. VIII.—Next in order is a coal ordinarily called the Twelve-feet Vein, but it is not in reality more than about 9 feet thick. This includes four benches.

Separating this coal from the next is a mass of sandstone, with a little slate, of a thickness of 70 feet.

Coal No. IX.—This is a double coal of two thin seams, the whole measuring, with the interposed slate, about 6 feet, and yet not containing coal enough to be workable.

About 30 feet of rock-sandstone now interpose, then we have the next coal.

Coal No. X.—Upon the sandstone rests a bed of coal, which, as it was shafted, seemed to have a thickness of 4 or 5 feet. This, at the Little Breaker, is shown in the Section.

A thick mass of Pea-conglomerate and coarse sandstone follows Coal No. X.: it has a thickness of not less than 160 feet.

Coal No. XI.—The next seam of coal is not a pure one, but consists of alternating coal and slate. In the shafts sunk upon its outcrop it appeared to have a thickness of 8 feet.

Succeeding this occur a grey sandstone and sandy slate through a thickness of nearly 200 feet.

Coal No. XII.—We now come to a thin coal-bed met within the point of the ridge just S. of the town of Ashland; the drift is obscure, and no record remains of the thickness of the seam, which is evidently not great.

Between this last-mentioned coal and the cessation of all rock-exposures near the middle of the valley, and nearly coincident with the main street of the village, there are about 200 feet of strata imperfectly visible, consisting of sandstones, slates, and shales, and in these have been found two or three very thin seams of soft and impure coal. This brings us to the uppermost Coal-measures, saved from denudation in this portion of the Ashland Basin.

We have here enumerated twelve independent beds of coal of various dimensions, from 2 feet to 25 feet; but of this series there are only about four which, under present circumstances, it is worth the while of the colliers in this district to mine upon a scale of any magnitude. So greatly more remunerative are the lower thick beds, extending in breasts more than half the height of the mountain above the water-level, that the thinner seams, especially the upper ones, are naturally for the present neglected.

FLEXURES AND COALS ON BIG MINE RUN.

The flexures and relations of the few coal-seams developed along Big Mine Run must be now briefly mentioned. There are three anticlinal undulations S. of the main axis of Locust Mountain. The most Northern of these is the Shenandoah anticlinal, or axis No. 4; and the most Southern is that which, a little E. of the Catawissa Road, lifts a large coal as it rises and expands to the E.; while the middle axis, apparently a very short one, is that which occurs in Repplier's Tunnel on Locust Run.

The large bed of coal shown dipping S. at an angle of 32°, as it is mined at Bast and Company's Colliery on the W. side of Big Mine Run, is, upon the most natural view we can adopt, the same seam which is seen dipping N. on the N. side of the Locust Mountain axis. From the position of this great coal, so far to the N. of the range of the most Northern ascertained outcrop of the Mammoth Vein, and from the uplifted condition of the strata, I am disposed to consider it as the Mammoth Seam of another flexure; and this view will receive confirmation upon a comparison of this section with those illustrating the state of things on Little Mine and Locust runs.

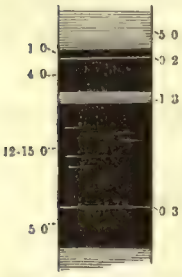


Fig. 234. — Mammoth Coal, Big Mine Run.

For the subdivisions of this so-called Mammoth Coal on Big Mine Run, see the cut here attached.

FLEXURES AND COALS ON LITTLE MINE RUN.

A study of the relative distances, thicknesses, and dips of the several coal-beds opened on the W. side of Little Mine Run, with the more conspicuous intervening rocks, makes it appear that there exist at that ravine two important anticlinal flexures, the more Southern one having the inverted form, while the more Northern has a normal shape. S. of the Southern or folded

arch is one of the two very thick coal-seams of the district, the thickness of which at its outcrop is 26 feet, and next S. of this occurs another bed of medium size, here having a diameter of about 11 feet. This latter has been regarded by some persons as the true Mammoth bed, while the first-mentioned is considered by them to be the Jugular. Upon this view, the inverted coal seen next N. of the fold, and represented as 9 feet thick, is the lower or Jugular Vein, while that which outcrops next N. of this, and given in the section as 7 feet thick, must be regarded as the inverted leg of the arch of the Mammoth bed.

Opposed to this hypothesis is the fact that the fourth of these large coals, or the second one N. of the arch, is manifestly not inverted, but displays a top slate, with ferns resting in natural position *upon*, and not beneath it, and a bottom shale with Stigmaria *supporting*, and not overlying it. In its coal, moreover, it exhibits none of the ordinary signs of a movement of inversion, but exhibits every symptom of having been lifted only into a normal dip. It is, in other words, one of the most regular beds embraced in the section. We are therefore constrained, while we admit the inversion in the strata immediately N. of the arch, to assume a synclinal flexure just S. of this 7-feet bed; or to conceive, in other words, that the 9-feet inverted coal and it are one and the same stratum folded back again. Upon this view, which is inconsistent with the idea that these only moderately thick beds N. of the axis are parts of either the Mammoth or the Jugular coals, we can hardly avoid identifying them with the second bed S. of the arch, represented as containing a mine-drift, and as measuring 11 feet in thickness.

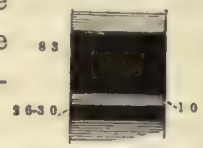


Fig. 235.—Patterson's Coal, Little Mine Run.

The coal, 11 or 12 feet thick, S. of the folded flexure on Little Mine Run, and called Patterson's, is shown in the accompanying cut.

FLEXURES AND COALS ON LOCUST RUN, AND ON THE CATAWISSA ROAD.

(See Section, Plate IV.)

A recent revision of this neighbourhood (1857) has enabled us to clear up some of its seeming obscurity. The very persevering and skilful experimental shaftings and provings carried on adjacent to Locust Run, and on the Catawissa Road and in the Mahanoy Mountain at the Ashland Gap, have furnished us with data for the construction of a section which represents, we think, pretty nearly the true structure of this part of the coal-field. The great seam, or Jugular bed of Ashland, is thrown by a fault into two outcrops on the brow of the mountain. On the N. side of the basin it is folded back under itself into an inverted or S. dip, and its arch is denuded into two outcrops supposed till lately to indicate two separate large coal-beds. It rises again further N., twice to the level of the road, high on the slope and summit of Locust Mountain. The Section exhibits all the dips, distances, and thicknesses now ascertained by mining and measurement.

ANTICLINAL FLEXURES AND INTERVENING BASINS OF THE SHAMOKIN COAL-FIELD, WITH THE COALS WHICH THEY PRESENT.

Anticlinal No. 6—that of Locust Mountain.—This important axis, already defined as bounding the Shamokin Coal-field on the S., originates in the valley of the East Branch of Big Mine Run somewhere N. of Girardville, and apparently about one-third of a mile S. of the Southern slope of Big Mountain. It does not impress itself on the topography until it reaches Big Mine

Run, on the W. of which the arch indicates itself in a knob, around the E. end of which flows the W. branch of that stream. Rapidly ascending from this point Westward, it forms the S. part of the high table-land S. of the Shamokin Mountain, across which passes the Ashland and Catawissa Road. From the Catawissa Road westward it continues to rise nearly to the centre turnpike, beyond which it slowly subsides to the neighbourhood of Locust Gap, where the axis seems again to ascend in its progress, until, by finally lifting out the soft Umbral rock subjacent to the coal strata, it separates the conglomerate which previously spans it into two monoclinal outcrops, the S. one slowly swinging Southward to unite with the crest of the Mahanoy Mountain, and form the high synclinal summit called the Locust Knob, and the N. one holding onward, but deflecting slightly Northward, to constitute thence the monoclinal South-bounding mountain-ridge of the Shamokin Basin. Between the Catawissa Road and the Locust Gap, the line of this axis is not straight, but curves sensibly convex Northward; but from Locust Gap to the cove of Red Shale through which it passes out from between the Coal-measures, it appears to hold a nearly direct course.

Strata elevated to the Surface by this Anticlinal.—The rocks which denudation has laid bare on the back of this anticlinal wave at its Eastern origin, are the middle Coal-measures; but from Big Mine Run to a point about one-third or half a mile W. of its intersection with the Catawissa Road, they are only the lowest of the productive coal-rocks; while from the point mentioned to Locust Gap, and indeed throughout its entire length to the Red Shale cove at Locust Knob, the materials exposed are the different members of the conglomerate beds which underlie the true Coal-measures.

In that section of its length which extends from near the Catawissa Road to Locust Gap, especially the portion a couple of miles E. and as many W. of the centre turnpike, there would seem to be two or three subordinate flexures on the back of the main anticlinal wave, the more Eastern of these passing Northward of those originating further W., a structure which perhaps is connected with the slightly convex sweep of the mountain in this neighbourhood. The Map will illustrate their position.

In the deep notch, called Locust Gap, by which this anticlinal ridge is cut to its base, the upper Egg-conglomerate, in a massive stratum 40 or 50 feet thick, may be seen rising from the bed of the notch in a regular arch, the crown of which is about 100 feet above the level of the stream called Locust Run, which, issuing from the Western part of the Mahanoy Valley, flows N. by the gorge to join the Shamokin Creek. The arch here is nearly symmetrical, the strata of its N. and S. abutments dipping about 20°. On both sides of this arch are several regular terraces or benches, formed by the denudation of the softer strata—namely, the coal-beds, and the slates adjoining them; and these terraces or benches, as they are familiarly called, extend with greater or less regularity along both flanks of the mountain throughout its entire length.

Anticlinal No. 7—that of Mine Ridge and of Mount Carmel.—Passing, in the next place, to the consideration of the first long anticlinal N. of the foregoing one of Locust Mountain, and deferring the description of the several subordinate ones included between these two principal waves, until the synclinal belt including them is under treatment, we have an axis of remarkable length and straightness. Coming from the East, it follows for several miles the N. foot of the Big Mountain, to where this throws a spur Eastward about $2\frac{1}{4}$ miles N. of Girardville. Here the saddle enters the coal strata by leaving the Red Shale at the head of the cove, between the main

mountain and its spur, and traversing a table-land of the Seral conglomerate between this cove and the Catawissa Road. This table-land, partly anticlinal, partly synclinal, contracts Westward beyond the Catawissa Road into a mere mountain-spur, along the S. brow of which now runs the anticlinal-line. One mile W. of the road, the broad spur becomes a narrow ridge of symmetrical profile, the crest of which droops quite rapidly thence to the forks of Shamokin Creek. This end of the mountain is called Mine Ridge. The anticlinal by no means terminates with the end of the ridge, but pursues its course in an exceedingly straight line for many miles Westward. Passing through the S. edge of the little table-land on which is seated the village of Mount Carmel, it ceases a mile further to elevate any ridge at all, but about 2 miles to the Westward of Mount Carmel it again makes an impression on the surface, holding up the low table-land over which the Mount Carmel and Shamokin Road passes, and which here begins to assume the name of Green Ridge. The axis follows the summit of Green Ridge to the gap through which the Shamokin Creek passes North-westward, exhibiting there a fine arching of the coal strata; and holding the same straight course, it extends along one of the crests of this ridge prolonged, till it crosses Buck (?) Run about 1500 feet S. of its mouth, at the bend of Shamokin Creek, beyond which, in the same line, it crosses Gerhart's Run, 700 feet above its mouth, and Mowray's Run, some 2900 feet S. of its junction with Carbon Run, following in all this part of its course the crest of the same narrow ridge. The Western termination of this anticlinal is in the high ground N. of the crest of Mahanoy Mountain, opposite the sources of Carbon Run. By the slow Northward trend of the Mahanoy Mountain, this anticlinal, like several others which adjoin it, gradually converges towards that ridge, rising and flattening itself as it obliquely approaches the crest or N. flank of the mountain. Opposite the vicinity of Locust Gap, this Mount Carmel anticlinal presents its greatest depression, and is the only section of its course where it is at all obscure: but for the perfect coincidence in line between its Eastern and Western halves, we might suspect that there are in reality two flexures—one sinking Westward to this neighbourhood, and the other Eastward from the flank of the Mahanoy Mountain. Future mining operations will probably determine the question of the strict continuity of the two portions of this long anticlinal line. The fact that the Locust Mountain axis undergoes a considerable subsidence of level in this vicinity, seems to be confirmatory of the view here presented of the strict continuity of the Mount Carmel flexure.

Strata exposed by Denudation along this Anticlinal.—From the head of the cove of Red Shale, not far E. of the Catawissa Road, to a point about 1½ miles W. of that road, the different members of the Seral conglomerate present themselves in succession, arching over the anticlinal axis as it very slowly sinks towards the W. At the point where the last uppermost beds of the unproductive conglomerate hide themselves, and the Coal-measures in ascending order saddle the axis, the anticlinal crest commences to fall more rapidly, descending in the next mile and a half to the point of Mine Ridge. The most Eastern spot at which clear indications of coal have been discerned by us, is upon, or very near, the crown of the arch, and about 1½ miles E. of this termination of the ridge. This coal appears to be one of the lowest; but all that part of the coal series which spans the anticlinal near the end of the ridge has been explored for coal, and three beds have been brought to light. The lowest principal bed here denuded at the very axis into two outcrops is probably Coal No. VIII. of the Shamokin Basin series. It has a thickness at these outcrops of 13 and 16 feet. A higher coal is exposed at Mount Carmel, just S. of this axis; but from Mount Carmel westward for more than 3 miles, we know at present extremely

little of the coal-beds which arch the anticlinal in the most depressed part of its course. Where Green Ridge, however, begins to assume some elevation S. of Quaker Run, the strata have been successfully explored for coal; and about 1½ miles E. of Green Ridge Gap, the large coal, No. 8 of the series, has been cut from off the summit of the wave into two outcrops. At the arch in Green Ridge Gap (see fig. 236), the generally thick Coal No. V. ascends above the water-level to span the axis, forming a curve about 1100 feet wide at its base. Buck Ridge, as that part of the hill between Green Ridge Gap of Shamokin and Buck Run is called, likewise exposes a narrow belt of the lower Coal-measures, between two outcrops of Coal No. VIII. Westward of Buck Run, the anticlinal slowly rising and the denudation growing upon it proportionately less, the two outcrops of Coal No. VIII. approach each other, until they coalesce again a little E. of Gerhart's Run. From this ravine to our Cross Section, Westward of Shamokin Gap, the axis is saddled throughout by very nearly the same division of the Coal-measures—that is to say, Coal No. VIII., which in some places overlaps it, and in others is denuded into two contiguous outcrops.

To assist to a full understanding of the strata exposed along this extensive line of flexure, the reader will do well to consult our sections across the coal-field, commencing with that next W. of Ashland, and terminating with the section W. of Shamokin Gap.

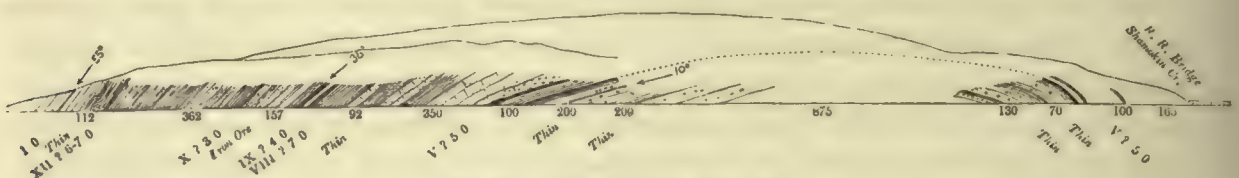


FIG. 236.—Section at Green Ridge Gap.

SYNCLINAL VALLEY OR BASIN NO. 7, BEING THAT BETWEEN THE LOCUST MOUNTAIN AND MOUNT CARMEL ANTICLINALS, AND HERE CALLED THE MOUNT CARMEL BASIN.

As already intimated, this long valley in the strata is connected Eastward with the Northern trough of the general Mahanoy Basin, by the subsidence in that direction of the anticlinal of Locust Mountain. That trough, situated on the S. base of Big Mountain, and limited Southward by the Shenandoah anticlinal, or No. 4, has its E. origin at the N. branch of the Mahanoy; its greatest breadth N. of the Shenandoah stream and ridge; and its junction Westward with this Mount Carmel Basin in the vicinity of Big Mine Run. There it forks, by the rising-up of the axis of Locust Mountain, into two subordinate troughs. The Northern one, following the base of the Big Mountain, which presently becomes the Shamokin Mountain as we pass the watershed between the Mahanoy and the Shamokin streams, soon takes the form of a wide symmetrical trough between the wide axis of the Locust Mountain and that of Mount Carmel. From the Catawissa Road, where the Shamokin and Big Mine Run of Mahanoy nearly interlock, the bed of the valley gradually descends Westward, watered by the Southernmost branch of the Shamokin as far as the gap in Jamie's Ridge, one-third of a mile E. of Mount Carmel. The S. branch of Shamokin Creek, joined by the middle branch at the point of Mine Ridge, and flowing forward half a mile within the basin, breaks through the low double ridge of Mount Carmel, Northward; it flows along the N. base of the Northern or Jamie's Ridge, breaches it by a second gap half a mile Westward of Mount Carmel, and, crossing the two anticlinals, enters once more the Basin No. 7, which we are describing. A little further Westward, the N. branch of Shamokin,

after passing through a third notch in Jamie's Ridge, and thus crossing both that axis and the true Mount Carmel one S. of it, likewise falls into the Shamokin Creek in this well-watered basin. From this point the main Shamokin stream maintains its course within the basin for several miles, until, being opposed by the rise of a group of small Western anticlinals, it is deflected Northward so as to pass out of the trough through the picturesque gap of Green Ridge. But in this middle part of the basin several mountain tributaries, the chief one of which is Locust Run, entering it through Locust Gap, contribute to swell the Shamokin Creek, and to irrigate the surface of the valley.

The configuration of this basin is that of a simple synclinal trough the whole way from the Catawissa Road to Mount Carmel; but, passing the latter locality, its structure becomes more complex through the introduction of first one, and, further Westward, of several subordinate anticlinal flexures, the influence of which is seen in the increasing variety and seeming irregularity in the topographical features of the district, as we trace it Westward to Buck Run. Viewed largely, the basin presents from this cause three divisions, as respects its structure and its scenery: an Eastern one, a simple mountain-trough watered by the S. branch of the Shamokin; a middle one, drained by the main Shamokin, and not bounded on the N. by any well-defined ridge or creek, but by a low and irregular table-land; and a third Western one, a high-rolling plateau leaning against the Mahanoy or monoclinal prolongation of Locust Mountain, and rising gradually Westward to merge itself into it as part of its long Northern slope.

SUBORDINATE ANTICLINAL FLEXURES IN THE MOUNT CARMEL BASIN.

Before proceeding to a statement of the Coal-measures actually developed and inferred to exist in the different parts of the Mount Carmel Basin, it is expedient to take a rapid glance at the subordinate flexures which undulate its bed.

Anticlinal A *of Basin* 7.—Commencing with the most Eastern subordinate axis, and referring to the Map to convey an exact conception of its position, I may describe it as originating on the E. at the foot of Mount Carmel somewhere near our section, for no vestige of this flexure is to be seen on the centre turnpike. Passing about 1000 feet S. of the mouth of the North Branch of the Shamokin, its structure is best exposed in this neighbourhood, where it crosses the Shamokin Road, and afterwards the Shamokin Creek, about 1200 feet N. of Locust Run. Entering the wide low table-land of Green Ridge, it disappears as a mere low wave in the strata. Everywhere throughout its course this is a very flat or gentle flexure, and its influence, therefore, in lifting out the Coal-measures, is comparatively unimportant. It is the principal cause, however, of the broad high plain which spreads N. from the foot of Locust Mountain nearly to the Shamokin Creek, and over which passes the Minersville Road.

The lowest coal-bed lifted to the surface anywhere along the course of this anticlinal, seems to be that which the Coal Mountain Company is now mining near the axis, and which I am disposed to regard as Coal No. 9 of the Shamokin Series. This seam is about 6 feet thick, and comprises three or four benches of coarse hard bird's-eye coal; this is at the Old Orchard drift.

Anticlinal B *of Basin* 7.—Next in order among the subordinate anticlinals of the basin is one which seems to originate some distance W. of the Western termination of the preceding, and a

little S. of its line of bearing. It commences, that is to say, N. of the Shamokin Creek, on the S. side of the table-land of Green Ridge, and crossing the Shamokin near the concave bend above the mouth of Wackle's Run, it passes through the N. side of the point of Buck Ridge, the main crest of which it then follows as far as Buck Run. Here the flexure, marked by a steep S. dip and a very gentle N. one, is still discernible; but how far beyond this stream it prolongs itself, we are unable, in the obscure condition of the surface, and the absence of mine-openings, to determine. It would seem, however, not to reach our section E of Gerhart's Run. This anticlinal, in the middle part of its range, or from the end of Buck Ridge to Buck Run, appears to be a flexure of considerable steepness, especially as respects its S. side,—a fact which is distinctly expressed in the topography of the belt of country traversed by it. Its N. dips are very gentle in consequence of the contiguity of a flat anticlinal to the N. of it.

Of the coal-beds elevated to the surface along this anticlinal we know but little, except near the E. end of Buck Ridge and at Buck Run. Nowhere does it seem to expose to view the large coal, No. VIII., but throughout its length it is saddled by the group included between that coal and No. XII. or XIII. Coal XII. has been opened by shafting just at the axis on the N. slope of the point of Buck Ridge, and one or two beds between that seam and Coal VIII. are accessible at the passage of the axis across Buck Run.

Anticlinal C *of Basin* 7.—There is a small flexure developed by shafting very near the Mahanoy Mountain, on the cross section at the sources of Gerhart's Run. In position it seems to lie somewhat to the S. of the course of axis B of Basin 7. This short flexure originates apparently somewhere near the Shamokin and Mahanoy Road, and, running W. obliquely towards the crest of the mountain, dies away high on its flank opposite Mowray's Run. The coals which it arches are those immediately above the large seam, No. VIII.

Anticlinal D *of Basin* 7.—Just W. of the passage of Shamokin Creek, across the end of Buck Ridge, and through Green Ridge, we detect another anticlinal flexure on the N. flank of Buck Ridge. Whether this axis exists at all in Green Ridge, or to the E. of the Shamokin Creek, is at present a matter of doubt, but the topography of that table-land does not intimate its presence. It is a flexure of considerable length, and of remarkable parallelism with the axis of Buck Ridge, and indeed with all the subordinate flexures of the Western division of Basin 7. It is not more than 600 feet distant from the main Buck Ridge anticlinal, or axis B, both at the end of the ridge, and on Buck Run; and on the section at Gerhart's Run, it is distant from axis C about 1000 feet. In its Eastern portion it is a wave upon the N. flank of Buck Ridge; in its Western, an undulation on the long slope of the Mahanoy Mountain.

There is a very feeble flexure of the strata from 700 to 1000 feet N. of the crest of the mountain, or from 400 to 700 feet S. of axis E, indicated on the local cross-section of the Scott and Hunter tracts, and this is probably the W. prolongation of the anticlinal D.

Coals exposed along Axis D *of Basin* 7.—Near the end of Buck Ridge, Coal No. XII., or the same seam which saddles the anticlinal B in that neighbourhood, arches over this flexure, and separates, going Westward, into two outcrops. In like manner, as we advance along the anticlinal, after once attaining the summit-level between the Shamokin and Buck Run, and especially as we descend into the ravine of Buck Run, lower and lower coals are exposed by the W. ascent of the axis, and by denudation, until near the bed of that ravine the large coal, No. VIII., is accessible on both its dips above the water-level. Passing Buck Run, the next higher coals lap over the anticlinal, and even when we reach the section at the head of Gerhart's Run, only the

covering rocks of Coal VIII. are at the surface, the coal itself not cropping out. Here the S. dip of the saddle being extremely gentle, we have an intimation that the axis is almost exhausted, and that, after forming for a short distance a belt of horizontal measures, it vanishes altogether, and leaves its space occupied by only N. dips. In the central part of its range, or where it crosses Buck Run, the N. limb of this arch becomes extremely steep.

Anticlinal E *of Basin* 7.—The fifth and last-recognised anticlinal of the Mount Carmel Basin is, like the preceding, confined to its Western division, or that beyond the Green Ridge Gap. Originating on the N. slope of Buck Ridge east of Buck Run, it crosses this stream above its forks, and, ranging parallel with the others, runs on to the tributaries of Buck Run, which it likewise crosses as it rises obliquely past the head of Mowray's Run into the sloping flank of the Mahanoy Mountain, where it disappears. Both on Buck Run and Gerhart's Run the N. side of this flexure is very steep; but at the more W. of these localities its S. dips, also steep at Buck Run, have become very gentle. This marks a near approach to the final termination of the flexure, the manner of its disappearance being evidently analogous to that of anticlinal D next S. of it.

Coals exposed on Axis E *of Basin* 7.—At Buck Run the anticlinal E exposes both dips of Coal No. X. immediately at the axis, a little above the water-level of the ravine; but E. and W. of the stream, where the denudation has been less, the next higher coals seem to lap over the arch; even on the cross section at Gerhart's Run, a coal, apparently the same, has been shafted just at the axis on a N. dip; and it is not until we reach a point opposite Mowray's Run that it appears to bring up Coal VIII. Still further W., for the anticlinal is a long one, it exposes at the cross section of the Scott Tract, and probably at a cross section a little W. of this, the still lower coal, No. VII.; here the flexure is within 1200 feet of the crest of the mountain, and its S. dips are very feeble, showing that it is almost gone.

Anticlinal F *of Basin* 7.—We come now to the last of the W. group of anticlinals included within the basin bounded by the main axis No. 7. It is seemingly a short and feeble undulation of the strata, not recognisable as far E. as Gerhart's Run, and not developed on Mowray's Run, if indeed it exists there. Our knowledge of it is confined to the developments made by shafting on the local section of the Scott and Hunter tracts.

Coals on Axis F, *Basin* 7.—The lowest coal exposed to view near this axis is Coal V., showing that this is a flexure of considerable lifting power, or, in other words, that it is here rising rapidly to the Westward.

OF THE SEVERAL SUBORDINATE BASINS EMBRACED IN BASIN NO. 7, OR THAT OF MOUNT CARMEL, AND OF THE COALS CONTAINED IN THEM.

Proceeding now to the consideration of the subdivisions of the Mount Carmel Basin, or those lesser synclinal flexures into which it is separated by the anticlinals just above described, and to the Coal-measures which have been preserved from denudation in them, and commencing as usual at the E. end, we have to note their positions and contents as follows:—

Basin a of Basin 7.—Designating the E. division of the general basin No. 7, or that watered by the South Branch of the Shamokin, as basin *a*, we will here recall attention to what has been already said respecting the simplicity of its synclinal structure. Bounded on the S. by the axis of Locust Mountain, which exposes throughout nearly the entire length of this trough the conglomerates below the coal-seams, the S. border of the Coal-measures within this trough is usually

from 500 to 800 feet below the crest of that mountain. The only exception to this state of things is W. and E. of the Catawissa Road, where the lower Coal-measures themselves saddle Southward over the axis, to pass uninterruptedly into the N. basin of the Mahanoy. From the vicinity of the Catawissa Road westward along the flank of Locust Mountain the limit of productive coal gradually gets lower on the mountain as far as the centre turnpike, beyond which it as slowly climbs its slope again towards the Locust Gap. On the opposite side of the basin, the true coal-bearing rocks ascend to within a few hundred feet of the crest of the Mine Ridge Spur of the Big or the Shamokin Mountain, as we may here indifferently designate the high plateau traversed by the Catawissa Road. The gradual sinking of this anticlinal Westward causes the boundary of the coal to approach the crest, and finally to cross it at a point once before indicated as that of the disappearance of the conglomerate on the back of this broad saddle. This point is rather more than 1½ miles W. of the Catawissa Road. From thence to the point of the ridge at the fork of the South Branch of Shamokin, higher and higher Coal-measures come in along the N. edge of the basin, until the large vein No. VIII. there shows itself; and with the progressive subsidence of the axis, a considerably higher coal occupies a like position at the turnpike at Mount Carmel. It is obvious, then, that whereas only the lowest part of the White-Ash coal series has been retained within the trough in the vicinity of the Catawissa Road, a much more elevated portion of the Coal-measures remains in the W. end of this division of the coal-field in the neighbourhood of Mount Carmel. There, indeed, the upper coals pertain apparently to the Grey-Ash group, or the bottom of the Red-Ash group; and supposing the entire series of the Shamokin coal series in existence thus far towards the E., at a point not positively established, there must lie within the centre of the trough in this neighbourhood not less than thirteen or fourteen separate coal-beds.

Basin b of Basin 7.—The introduction of the low subordinate anticlinals or saddles *a* and *b* to the S.W. of Mount Carmel, divides the general basin No. 7 into two lesser troughs. The more S., and much the most capacious of these, situated along the foot of the Locust Mountain, and prolonged into the flank of the Mahanoy Ridge, we designate as basin *b* of Basin 7, while that N. of the two saddles, ranging for the chief part of its length through the plateau of Green Ridge, we may entitle basin *c*.

The branch basin *b*, traversed in the middle part of its course by the Shamokin Creek, and there bounded on the N. by Green Ridge, commences more than one mile E. of Locust Gap, and ends apparently W. of Buck Run, probably at the head of Gerhart's Run.

Coals in Basin b of Basin 7.—Throughout nearly its entire length, from opposite the North Branch of Shamokin to the head of Buck Run, this fine trough of the Coal-measures contains all, or nearly all, the coal-seams embraced between the bottom of the series and the Grey-Ash group. Even E. of Locust Run, it probably holds relatively narrow tracts of the Tenth, and even the Twelfth beds; and in its more central districts, probably the Grey-Ash coals themselves, or about No. XIV. This last statement is rendered probable by our finding Coal XII. saddling the axis of Buck Ridge near the E. end of that hill. Even as far Westward as the head of Buck Run, we find what is probably Coal XI. near the centre of this basin, and No. X. itself has been shafted in the same central line of the trough on the section just E. of Gerhart's Run. The statements already made respecting the coals brought to view along the two saddles *a* and *b*, will suffice to indicate the lowest which have their outcrop along its N. margin. It is along its S. border, or in the terraces of the Locust and the Mahanoy ridges, that the lowest coal-beds basining within

this trough have their outcrops at the surface. There they may be mined by slopes, and in some of the more favourable ravines by drifts, endwise into the mountain, but along the central or synclinal portion of the valley they will be best reached by perpendicular pits or mine-shafts.

On both sides of Locust Gap, Coal VIII., or the Mammoth Seam, is now mined. On the E. side it presents the dimensions and divisions shown in the cut.

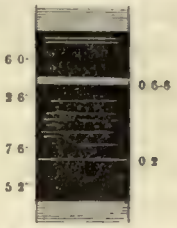


FIG. 237.—Connor's Mammoth Coal, Locust Run.

Basin c of Basin 7.—The Northern of the two branch basins of Basin 7 commencing near Mount Carmel, and bounded by the saddles *a* and *b*, receives for the first 2 miles the drainage of Shamokin Creek, till this stream is deflected by the E. end of Green Ridge into basin *b* South of it. From this point of passage of the Shamokin to its place of return Northward through Green Ridge, the basin lies entirely in the broad flat low table-land forming the E. end of the ridge—this table-land being the result, in fact, of the anticlinals of Buck Ridge, and of Green Ridge or saddle *b*, and the main axis No. 7. To the W. of the Green Ridge Gap the trough soon terminates as a simple synclinal, by the introduction of the anticlinal flexures *d* and *e*; and indeed it is not expedient to regard it as a simple basin W. of the passage of the Shamokin through the ridges.

Coal-beds preserved in Basin c.—Coal X. appears to be the highest bed yet developed or likely to be found in that part of basin *c* which is occupied by the Shamokin Creek, though Eastward of the commencement of the trough, or near Mount Carmel, higher beds, as I have already shown, lie in the same belt of ground. The insertion of the saddle A evidently renders this basin more shallow than the wider one E. of it. The W. division of the trough, or that occupying the table-land of Green Ridge, possesses probably about the same portion of the coal series until we approach the Green Ridge Gap, where Coal VIII., lifted by the Westward rise of the main anticlinal No. 7, occupies the Northern half of this trough. It is probable that coals as high as the twelfth of the series find a place in the basin along the S. side of Green Ridge, for there both the anticlinals A and B are either much depressed or altogether absent.

OF THE NARROW TROUGHS IN BASIN No. 7, W. OF GREEN RIDGE GAP.

It will be seen, upon inspecting the Map and Sections, that between the main axis No. 7 and the more local anticlinal B, the three subordinate saddles D, E, and F form, with these others, four parallel narrow synclinals in the prolongation of basin *c*, which we have been just describing. Having already indicated explicitly the several coals denuded at the axes of these anticlinals, it is unnecessary to mention in detail what highest coals are preserved within these four respective troughs. It will be sufficient to call attention to the sections which cross them, and to the general fact that the coal-beds IX., X., and even XI. and XII. in the higher grounds, are procurable in the less denuded portions of these basins between the Green Ridge Gap and Gerhart's Run; while W. of this stream, Coal VIII., and even yet lower coals, are generally the highest retained beds.

SHAMOKIN BASIN.

At the date of our last visit to the mines of the Shamokin Basin (September 1854), the following Coal Companies were in operation in the vicinity of Mount Carmel and Shamokin:—

Coal-Run Improvement and Railroad Company.—A tunnel was driven Northward across the

measures into the South-dipping rocks of Red Ridge from a point N.E. of Mount Carmel; at 34 feet from the mouth, it cut a coal measuring from 6 to 9 feet, of good quality. This bed has not much surface above it, and the tunnel was continued to a distance of 122 feet, where a thin seam of 1 foot was cut. Beyond this, larger coals are to be met, which the tunnel had not reached.

Locust Mountain Coal and Iron Company.—This Company at the same date were driving a tunnel Northward into Red Ridge, farther Eastward and 50 feet higher than the Coal-Run Company's. The first coal met in this tunnel was struck at a distance of 233 feet; it measured 2 or 3 feet. A slaty seam 1 foot thick was met 51 feet farther in, and at the end of the tunnel, 318 feet from the mouth and 34 feet from the slaty coal, a seam corresponding to the 9-feet bed cut near the mouth of the Coal-Run Company's Tunnel was passed through. It was proposed to push forward 120 yards more where the large seam, Coal VIII., would be met. Before reaching it, two smaller coals would be passed: the upper bed measures 4 or 5 feet at the outcrop; the lower 9 feet, though it is generally much thicker. The large bed will have a breast of 240 feet, at a dip of 50° or 60°.

On the line of our Section south of the above collieries, and on the N. side of Little Mine Ridge, a fine bed of coal overlying Coal VIII. is mined by Mr Eckel on a steep N. dip. Its thickness and subdivisions are annexed :—

	Feet.	Inches.
Coal,	3 to 4	0
Slate,	0	6
Coal,	6	0
Slate,	0	6
Coal,	4	5

The gangways are driven Eastward. The coal below, or No. VIII. of the Shamokin series, is mined in the same neighbourhood. Its subdivisions are as follows :—

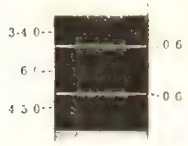


Fig. 238.—Eckel's Coal VIII., near Mount Carmel.

	Feet.	Inches.
Coal, good,	1	6
Coal,	3	0
Coal, bony,	0	6
Coal,	4	3
Slate and bony coal,	1	6
Coal, rough,	2	6

This coal has been opened on gentle S. dips on the S. side of Little Mine Ridge, and both of the beds have been proved yet further Southward on the N. dips of Locust Mountain, where their dimensions are large.

The *Coal Mountain Coal Company* are working two mine-drifts in the gap of Jamie's Ridge, W. of Mount Carmel. The Southern gangway enters a South-dipping bed of coal. Its thickness between top and bottom slates is 10½ feet, including 7 feet of workable coal. Not over 50 yards N. of this a 6-feet bed of coal is entered. The dip is 60°. The two openings are probably on the same seam. E. of Jamie's Ridge Gap the "Old Orchard Drift" enters upon a 6-feet bed of coal, dipping 5° N. The coal is divided into three or four benches, and exhibits a hard coarse bird's-eye variety.

The *Green Ridge Coal Company* have coal opened on both flanks of two anticlinals—that of Jamie's Ridge on the S., and Red Ridge on the N.

No. 1 drift-mine enters upon a coal dipping 45° S. on Jamie's Ridge; the coal measures 9 feet in four benches; the top bench, 4 or 5 feet thick, is the best. No. 2 mine, on the N. dips of the same axis, enters a coal 10 or 11 feet thick. The dip is 56°. This coal, and that of No. 1 drift, are no doubt the same. Over it several smaller coals are found. The lowermost measures 2 feet, a second 4 feet, and a third is not fairly proved. No. 3 gangway belongs to a bed dipping 15° or 20° S. from Red Ridge anticlinal. This seam is estimated to contain 16 or 17 feet of coal in five or six benches, of which the upper two and the lower are the best. Its ash is a light grey. The coal in No. 4 mine dips from 45° to 50° N. It is 13 feet thick, divided into several benches by partings of slate. From this mine 11 feet of coal are workable. The arch of Red Ridge anticlinal is finely exposed between Nos. 3 and 4 drifts.

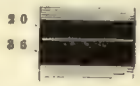


Fig. 239.—No. 1 Mine, Lancaster Colliery.

In Locust Gap, S. of the Green Ridge Company's mines, several fine seams of coal have been proved, and extensive collieries are about going into operation.

The *Lancaster Colliery* is situated near the end of Coal Run Ridge. Annexed are Sections of the coal-seams of Mines No. 1 and No. 2 of this colliery.

Fig. 240.—No. 2 Mine, Lancaster Colliery.

Anticlinal No. 8, *or that of Red Ridge.*—The next high leading anticlinal of the coal-field N. of No. 7, or that of Mount Carmel, is that of Red Ridge. This is actually traceable continuously no further than a little W. of the North Branch of Shamokin Creek, but as an axis exists almost precisely in the same line, about 2 miles further W., near Hornberger's, and the topographical features of the intervening ground are indicative of such a flexure, we can hardly hesitate to consider them as the same, and thus to extend the axis nearly to the valley of Shamokin Creek. But there occurs another anticlinal almost strictly in the same prolongation, ranging through the hill N. of the Shamokin Creek, and crossing the valley of that stream about 2000 feet N. of the mouth of Buck Run; and though I would by no means maintain, in the present imperfectly opened condition of the country, that this is a still further extension of the same axis, I deem it highly probable that it is a part of it. Possibly these two sections of the anticlinal W. of the North Branch of Shamokin may not be in exact line with each other and with the axis of Red Ridge, yet they lie so nearly in one range, and belong so strictly to the same belt of strata, that we cannot go far wrong for either scientific or practical deductions, if we view them as one continuous flexure. Adopting this enlarged notion of the anticlinal, it is one of the most important in the Shamokin coal-field, for it enters it at its Eastern end, issuing from the Northern of the two coves of Umbral Red Shale, or that embraced between the two Eastern spurs of the Shamokin Mountain; and ranging across the table-land of the Catawissa Road, and along the narrow crest of Red Ridge to its termination, it does not cease until it reaches the valley of Carbon Run.

This anticlinal flexure is of the normal type, like the other main ones which accompany it—that is to say, neither side of the curve is inverted. That portion of it which constitutes Red Ridge exhibits, like the anticlinal of Locust Mountain, a generally steeper S. than N. dip, neither inclination in Red Ridge exceeding, except in a few places, 45°. At the W. point of Red Ridge, and again near Little Quaker Run, and still further W., where it crosses the Shamokin S. of the furnace, the N. slope of the wave is in each instance a little steeper than the S. An additional fact connected with this anticlinal is the progressive steepening of the flexure as it prolongs itself Westward; for while, in its Eastern half, its dips, as stated, seldom surpass 45°, those which it

exhibits where it crosses the Shamokin Valley south of the town of Shamokin, are as steep as 60° on the S. side, and 70° on the N. side of the axis. This pinching-up of the wave, as it were, is by no means an uncommon feature in our anticlinals. In the present instance it appears to be connected with the unusual multiplication of flexures in that part of the basin which lies opposite Shamokin, a multiplication which suggests an unusual amount of inward compression of the two boundaries of the basin, produced probably at the elevation of the great external anticlinal waves, between which the whole coal-field lies as one corrugated or wrinkled trough. The true Western termination of this axis I have not been able to ascertain, but it is probably somewhere near the sources of Carbon Run.

COAL-MEASURES EXPOSED BY DENUDATION ALONG ANTICLINAL No. 8, OR THAT OF RED RIDGE.

At the passage of the Ashland and Catawissa Road across the Red Ridge anticlinal, the only rocks exposed for a distance of many hundred feet are the middle and upper beds of the Seral conglomerate, and we encounter on the axis the upper beds of the Umbral Red Shale; but a short distance—perhaps not a third of a mile—to the E. of this road, the anticlinal, which is here by no means steeply arched, by slowly subsiding Westward, allows the two margins of the lower Coal-measures, which it separates, to encroach gradually upon it as it sinks, until at a distance of about a mile W. of the Catawissa Road these outcrops unite, and thence forward to the termination of Red Ridge, and indeed to the Western cessation of the axis itself, it is saddled only by productive Coal-measures. At first the crest of Red Ridge is overlapped only by the lowest of the workable coal-seams, but near its point, where the North Branch of the Shamokin cuts through it, the large coal-seam No. 8, which may be viewed as in the middle of the White-Ash series, presents its two outcrops closely approaching each other, and within 1000 feet or so W. of the gap: these outcrops run together, and this, and even higher beds, from that point forward bend over the axis without being cut or denuded. Between the mouth of Cedar Run and Little Quaker Run, or the mouth of Big Quaker Run itself, much obscurity prevails respecting the coals brought to the surface along the anticlinal; we only know that they must be high in the series. That part of the axis which crosses Shamokin Creek exposes, near the water-level of the stream, coals which our Section shows must be about the thirteenth or fourteenth of the series, or those next above the White-Ash group, and it is obvious that somewhat higher beds prevail along the ridge through which the axis passes. The present state of the district does not enable us to be more specific.

Basin No. 8, *or that included between Anticlinals No.* 7 *and No.* 8.—The long narrow trough or basin embraced between the Mine Ridge or Mount Carmel anticlinal axis, and the similar axis of Red Ridge and its prolongation on the N., though quite as long as the basin S. of it, is both narrower and of less complexity. It contains, as far as we know, only four subordinate anticlinals, one of them in its Eastern half, and three in its Western. Before proceeding to the distribution of the coal in the basin, it is essential to describe these anticlinals and their effects on the strata.

Anticlinal A *of Basin* 8, *or Axis of Jamie's Ridge.*—This anticlinal seems to rise near the point of Mine Ridge, and to diverge Northward from the Mount Carmel axis at a very acute angle, and follow the crest of Jamie's Ridge. It holds up the N. edge of the plateau of the village of Mount Carmel, as the Mount Carmel axis does the Southern. Crossed by the South Branch or

Main Shamokin Creek once E. and again W. of Mount Carmel, it is next, at the distance of half a mile, at the third notch in the ridge, traversed by the North Branch of the Shamokin. From this point Jamie's Ridge grows wider and flatter, and indicates through its external structure less precisely the position of the anticlinal; but further to the W., where the axis crosses Quaker Run, we are once more enabled to fix its place with precision: this is just S. of the passage across the stream of the Shamokin Road. From this point it ranges on in the same straight course towards Quaker Run, beyond which we lose it.

The want of parallelism of this axis to the two principal ones which adjoin it, is a feature deserving of especial attention, particularly when we note that a similar want of parallelism prevails between axis A of Basin 7, and the main anticlinal No. 7, and that these two oblique anticlinals are themselves mutually parallel. This fact would seem to suggest that they owe their birth to a different movement from that which produced the larger anticlinals between which they are enclosed, and that they can hardly be regarded as merely secondary corrugations of the strata engendered by inward lateral compression of the sides of the general basin, or the special ones including them.

FIG. 241.—Section of Green Ridge and Red Ridge at North Branch of Shamokin Creek at the Collieries, looking E.

OF THE COAL-MEASURES EXPOSED ALONG AXIS A OF BASIN 8, OR THAT OF JAMIE'S OR GREEN RIDGE.

At the intersection of this anticlinal by the North Branch of Shamokin Creek—the point, namely, where the amount of vertical uplift along it seems to have been greatest—the lowest coal lifted into view above the water-level of the valley is the large seam, No. VIII. This spans the arch in a beautiful curve, dipping S. at an angle of 35° and N. at one of 50°; the bed is here about 12 or 13 feet thick. Outside of it, at each base of the ridge, are other higher coals. From this gap of the North Shamokin east half a mile to the passage of the main Shamokin, through the same ridge, the two outcrops of the large seam, ranging along the opposite sides of the ridge, gradually converge, until they come together just E. of the Shamokin. The E. descent of the anticlinal axis implied in this convergence, causes the coal to be saddled by higher strata from this gap E., so that at Mount Carmel the only coals exposed at the surface are those next above the big one. Still further E., again, the influence of the Mount Carmel axis upon this one shows itself in slightly lifting all the strata in that direction, so that Coal VIII. once more emerges from below the water-level.

In the opposite direction, or W. from the North Branch of the Shamokin, the axis either maintains its level for 2 or 3 miles, or sinks very slowly. Just S. of the axis on Quaker Run, a large coal has been opened in two places, that nearest the saddle measuring about 10 feet in thickness. Whether this is Coal VIII., or a bed higher in the series, we have not the data for determining; but I am disposed to regard it as a higher coal, probably No. X. or No. XII. Still further to the W., just on the S. brow of the low flat hill S. of Hornberger's, a coal has likewise been found basining a little N. of this axis, but what its thickness is, and what its exact place in the series, are points not yet known. I think it probable, however, that this is about Coal XII.

Anticlinal B *of Basin* 8.—Three other subordinate anticlinals occur in this synclinal belt, which we have called Basin No. 8. The most Southern of these seems to take its origin, or to have its E. end, on the N. slope of Green Ridge, between Shamokin Creek and Buck Run, where it forms, indeed, an independent lower crest. Crossing Buck Run about 600 feet S. of its junction with the Shamokin, the axis, ranging along the same line of crest, crosses Gerhart's Run about half a mile above its mouth, and Mowray's Run, 2000 feet S. of its junction with Carbon Run. Beyond this point the anticlinal ranges through the Scott Tract into the N. flank of the Mahanoy Mountain, expiring in a depressed flexure high upon its slope near the W. end of the high knob which the mountain exhibits S. of the head of Carbon Run.

Coals exposed along Axis B *of Basin* 8.—At the passage of Buck Run across this anticlinal, the large coal, No. VIII., ascending from the mouth of Buck Run, arches the saddle above the water-level of the ravine, but is not denuded on the ridge either E. or W. of it; but, basining between this axis and the main anticlinal No. 7, it outcrops to the N. of the latter. We know but little of the coal brought to the surface by the axis at its intersection with Gerhart's Run, but apparently it is Coal X. Further W., a coal, deemed by us to be Coal X., has been shafted near the axis both E. and W. of Mowray's Run. Reaching Section No. 2, W. of Shamokin Gap, the ascent of this axis is discernible in the rising out of Coal VIII. to the surface, pretty high towards the foot of the mountain. This is on the Scott Tract, beyond which no systematic diggings have been yet undertaken in quest of coal.

Anticlinal C *of Basin* 8.—Parallel with the preceding anticlinal, and at an average distance of 800 or 900 feet N. of it, ranges another long straight wave in the Coal-measures. This appears to commence towards the E., near the base of Green Ridge; or, more precisely, it first shows itself in the W. bank of the Shamokin Creek, a little W. of the mouth of Buck Run, where the next coal over the large bed just peeps to the surface, arches, and disappears again. From this spot the axis is traceable W. to where it is intersected by Gerhart's Run, and again by Mowray's Run, and still further to our Section-line W. of Shamokin Gap. Beyond this point it encroaches, like the preceding axis, upon the long sloping flank of the Mahanoy Mountain, and probably at last draws near to, or even merges into, its crest. If thus prolonged, its termination must be somewhere near the bend of the crest opposite the extreme source of Carbon Run. Like nearly all the axes S. of it, this anticlinal flattens its S. dips rapidly as it obliquely ascends the Mahanoy Mountain. It there however preserves, or even increases, the steepness of its N. dip.

Coals exposed along Axis C *of Basin* 8.—There can be little doubt that the coal brought to the water-level of Shamokin Creek by this anticlinal is No. IX. of our series, or the next seam above the large one, No. VIII. Just W. of Mowray's Run, coal has been opened at the axis, which is possibly Coal VIII. itself, though of the identity of this I feel uncertain. Further W. again, at the section through the Scott Tract, about the same portion of the series is again exposed upon the axis, and beyond this we know nothing specifically about it.

Anticlinal D *of Basin* 8.—Another shorter anticlinal occurs in the same belt in the W. part of Basin No. 8, also parallel with the rest, and S. of Carbon Run. At our W. section through the Scott Tract, it lies about 900 feet N. of axis C, where it occupies the crest of a flat hill, or a swell at the foot of the mountain. It is possible, judging from the topography, that this axis exists as far E. as the crest of the hill next W. of Gerhart's Run, but we have no specific proofs of its course either E. or W. of the section, where we have intersected it; we can only infer, from

certain topographical features, that, like the many axes S. of it, it advances W., encroaching upon the flank of the Mahanoy Mountain, until it expires somewhere N. of the summit. We are equally ignorant at present as to what coal this axis brings to the surface at our cross section, but we are entitled, from several considerations, to infer that it must be a bed high in the White-Ash series, perhaps Coal X. or XI.

OF THE SUBORDINATE BASINS INCLUDED IN BASIN 8.

Owing to the oblique position, in the general Basin No. 8, held by the anticlinal of Jamie's Ridge, this general basin is naturally subdivided into two portions—one extending from the Catawissa Road to about the mouth of Quaker Run, and the other from Mount Carmel to the place of disappearance of the Red Ridge axis somewhere on Carbon Run. I shall now pass to the consideration of these synclinals, and to an account of the coal strata which they contain.

Basin a of Basin 8.—The Eastern division of Basin 8, which we shall call Basin *a*, commences in a narrow point of the Coal-measures, about 1000 feet E. of the Catawissa Road, the trough originating on the spur embraced between the two coves of Umbral red shale which there head up into the Shamokin Mountain. Crossing the road, this synclinal rapidly assumes the form of a regular valley, which, descending W., is watered for nearly its whole length to the point of Red Ridge, first by the middle, and then by the Main Shamokin Creek. Contracting as it goes W. of the N. branch of the Shamokin, it soon loses altogether the structure of a valley, and the only streams which traverse it are Cedar Run, and the feeble N. tributaries of Quaker Run.

Coal-measures in Basin a of Basin 8.—From the points already indicated on Mine Ridge and Red Ridge, where the upper beds of the Seral conglomerate are saddled over by the lowest productive coal-seams, the crests of these two ridges, and of Jamie's Ridge, constitute the natural limits of this basin. Mention has been already made of the Coal-measures exposed at the borders of the basin by these anticlinals, and it now only remains to state what higher coals have been preserved from denudation in the more central or deeper parts of the trough. For the first mile W. of the Catawissa Road, it is probable that only the lower White-Ash coals, or those beneath the large bed, No. VIII., have any existence in the basin; but further along the valley, probably at our Section No. 8, and certainly at Section No. 7, we have the fullest evidence of the presence of nearly the whole of the upper White-Ash group. From near the point of Mine Ridge to near the termination of Red Ridge, the average depth of the basin is probably nearly constant, the gradual rise of the Jamie's Ridge axis apparently compensating for the slow subsidence of that of the Red Ridge. At the North Branch of the Shamokin Creek there are probably three or four coals in the basin higher than Coal VIII., but the width between the out-crops of the uppermost is of course inconsiderable. In the neighbourhood of Quaker Run and Little Quaker Run, the basin contracts to not more than one-half, or even one-third, of the breadth which it has E., yet it retains, by the subsidence of all the anticlinals towards this central part of the coal-field, the same upper White-Ash coals; but precisely what coal it is which basins on the ridge a few hundred feet S. of Hornberger's, it is impossible to say until more mining has been done.

Basin b of Basin 8.—Crossing the anticlinal of Jamie's Ridge, we proceed, in the next place, to trace briefly the coals left in Basin *b* of Basin 8, or that embraced between Jamie's Ridge and

the Mount Carmel anticlinal as far as Green Ridge Gap. At the narrow Eastern point of this synclinal belt, or the little plateau of Mount Carmel, the first coals under the surface are those, it would seem, which next overlie the thick bed, No. VIII., and the same may be said of that part of the basin which extends from the North Branch of Shamokin Creek to Quaker Run. Indeed, it is probable that the surface coals of the middle or synclinal part of the basin, throughout nearly its whole length to the mouth of Quaker Run, are those embraced between Coal IX. and Coal XII. inclusive; while W. of Quaker Run, with the disappearance of Jamie's Ridge axis, the bed of the basin, occupied by the Shamokin Creek, embraces three or four still higher coals. That this is true may be seen by inspecting our Main Shamokin cross-section, which exhibits the very highest coals of the district, dipping in synclinal posture in the centre of this trough. Beyond this intersection of the basin by the Shamokin Creek, N. of Buck Run, it is not practicable, in the present undeveloped state of the ground, to attempt a detailed tracing of its coal-beds. It will suffice to state that, following the trough W. to Carbon Run, we must there meet with lower and lower Coal-measures gradually coming up, as successive anticlinals—such as B, C, and D of the basin we are in—intrude themselves and give a Westward lift to all the rocks.

Having already specially indicated, as far as known, what coal-beds are brought to the surface by these subordinate anticlinal waves which lie between the two long axes No. 7 and No. 8, and having thus shown incidentally very nearly what the uppermost coals must be which they retain between the various cross-sections of Buck Run, Gerhart's Run, Mowray's Run, and those through the Scott Tract, it would be superfluous and tedious to attempt to define in more detail the uppermost coals of these narrow troughs. I shall therefore here terminate my description of Basin No. 8, and pass to the consideration of the anticlinal No. 9, or that of Coal Run Ridge, and of the basin next S. of it, or that of the North Branch of Shamokin Creek.

ANTICLINAL NO. 9, OR THAT OF COAL RUN RIDGE.

The last or most Northern main anticlinal of the coal-field is that of the mountain-spur of the Shamokin Mountain, called the Coal Run Ridge, which is the third of the chief mountain anticlinals of the proper Shamokin Basin, not counting the bounding one of the Locust Mountain. The three large anticlinal waves—that of Mine Ridge, of Red Ridge, and this of Coal Ridge—distribute the Coal-measures of the E. half of the Shamokin Basin into four very symmetrical synclinal troughs, the most Northern of which is the Coal Run Valley, embraced between this high axis and the monoclinal crest of the Shamokin Mountain. It will be observed, upon inspecting the Map, that these three mountain-spurs are successively longer the further N. they are, the Coal Ridge being longer than the Red Ridge, and this last longer than Mine Ridge. This interesting fact lends some countenance to the view which would make the Mine Ridge anticlinal, or No. 7, terminate near the North Branch of Shamokin; and that of Red Ridge, or No. 8, end either near the source or the mouth of Quaker Run. But even if this view be the correct one, the assumption that I have made, that these two axes are prolonged much further W., does not seem to vitiate any practical deductions. (The reader will gain a clearer conception of the relations of the coal strata in these ridges and basins, if he will here consult the 4th Section on Plate IV. of the Coal Sections, or that E. of Mount Carmel.)

The Coal Ridge axis enters the coal-field through the outer flank of the Shamokin Mountain, at a recess in its crest S.E. of the terminating knob of the Coal Run Basin. This

recess is really an anticlinal cove in the Red Shale, but shorter and less excavated than those through which the Red Ridge and Mine Ridge axes enter the basin. For about 3 miles W. from the synclinal knob, the crest of the anticlinal wave displays an extensive denudation of the Coal-measures, the summit of the mountain exposing, over an average width of more than 1000 feet, no coal-bearing rocks, but only the Seral conglomerate. But within less than half a mile W. of the passage of the centre turnpike across the ridge the axis commences rapidly to decline, and here the lower productive coal strata close over the conglomerate. Near this point the structure of the mountain becomes a little complicated, two additional anticlinals, one S. and the other N. of the main axis, appearing on its flanks, and running closely parallel with it. The main axis of the ridge, intersected by our shaftings, and clearly proved in position by openings in the coal-beds, and by observation upon the rocks, declining rapidly in its degree of flexure at Coal Run, crosses the valley of that stream only a little above the old gangways at the water-level in its W. bank. Here the S. dip from the axis is between 25° and 30°, while on the N. side it is nearly flat, from the lifting influence of the saddle next N. of it. Westward from Coal Run the main anticlinal very rapidly subsides, seeming hardly to reach the ravine of the Luke Fidler Colliery. Throughout the E. half of Coal Ridge the S. leg of the arch appears to be materially steeper than the N. one, but along the W. half to Coal Run the proximity of the waves upon its flank seems to interfere with the preservation of this form, the N. axis, or B of Axis 9, becoming soon a more inflected wave than the main one of the crest of the mountain. From a point about due S. of the passage of the turnpike across Shamokin Mountain, the subordinate S. axis of Coal Ridge, or A of Axis No. 9, seems to constitute a summit about as high as that of the main axis, and to form indeed the principal crest towards the end of the ridge. An inspection of Section 1 of Coal Run Basin shows the arch of Coal Run Ridge flat, or even slightly concave, on its summit, a structure which arises from the presence of two anticlinals, the main one, No. 9, producing the S. dip, and the auxiliary one, B of Axis 9, the N. dip. The S. axis, the feeblest of these, seems to expire altogether before reaching the gap of Coal Run, while the Northernmost is here even somewhat stronger than the chief or middle one, and prolongs itself considerably beyond it to the W. How near to the town of Shamokin this actually approaches, we are unable yet to say.

COAL-MEASURES EXPOSED ALONG THE COAL RIDGE ANTICLINAL.

The first productive Coal-measures over the Seral conglomerates appear to saddle the crest of Coal Ridge about half a mile W. of the centre turnpike. From this point W., higher and higher strata undulate across the complex anticlinal, until, at Coal Run Gap, the coals which rise in the double arch above the water-level are probably as high in the series as Nos. X., XI., and XII.

BASIN No. 9, OR THAT OF THE NORTH BRANCH OF SHAMOKIN.

Between the Red Ridge axis and the anticlinal of Coal Ridge occurs a long and quite regular synclinal trough in the Coal-measures, descending W. from the middle of the more Northern spur in which the Shamokin Mountain terminates E. The chief part of this spur, which, near its junction with the main mountain, is a high flat table-land, is covered only with the different members of the Seral conglomerate, no productive Coal-measures appearing to exist upon it further E. than about one-third of a mile E. of the Ashland and Catawissa Road. There the

true coal-basin begins in the middle of the flat synclinal table-land. Rapidly expanding, the N. edge of the true coal-basin presently gains the monoclinal crest of the Shamokin Mountain, and pursues it to the head of the recess at which the Coal Run axis enters it, beyond which the boundary follows the S. side of the flat summit of Coal Ridge to the point half a mile W. of the Centre Turnpike, where, as already intimated, the conglomerates are saddled over by the more productive coal-rocks, from which point to Coal Run Gap the N. limit of the basin must be considered as the chief axis of Coal Ridge, whichsoever this may be along the different portions of its undulated summit.

Following next the S. limit of the productive coal-basin, we still find the line crossing the Catawissa Road a few hundred feet N. of the crest of Red Ridge, and gradually ascending that crest until, at a distance of perhaps three-fourths of a mile W. of the road, it turns across it, and is joined by the N. edge of the same coal-rocks belonging to Basin No. 8, south of it. From this point of the first saddling of the Coal-measures the true S. limit of Basin No. 9 is the anticlinal axis of Red Ridge, approximately coincident with the crest of the mountain. To the W. of the notch in the end of the ridge, at the passage of the North Shamokin Creek, no well-defined topographical feature bounds the basin on the S. as far forward as Coal Run, unless, indeed, we generalise the range of hills passing N. of Hornberger's into a sort of broken ridge. The structure of the general synclinal belt between Axis No. 8, south of Shamokin, and the line of extension of the Coal Ridge anticlinals, is so undulated W. of Coal Run Gap, especially near Shamokin, there being in this interval at least four anticlinal waves, that it is not expedient to consider Basin No. 9 as really prolonged any further in that direction.

OF THE COAL-MEASURES PRESERVED IN DIFFERENT PARTS OF BASIN No. 9.

Though this basin of the N. branch of Shamokin Creek is from its Eastern end to Shamokin Creek remarkably regular and free from undulations, yet it is not entirely exempt from them; and for the sake of accuracy in my description of the distribution of the coal-beds within it, an allusion to the positions occupied by these subordinate flexures is indispensable.

First, there occurs in the N. slope of Red Ridge, not 1 mile E. of the gap of North Shamokin Creek, a gentle undulation, exhibiting a very feeble S. dip, with a steeper N. one, the axis being about 800 feet N. of the main anticlinal of the ridge. The effect of this is to lessen the number of separate coal-seams in this part of the mountain, while it multiplies their outcrops. How far this small flexure, which properly belongs to the anticlinal wave of Red Ridge, extends E. and W. along its flank, it is impossible in the present unopened condition of the basin to ascertain.

The second and only other known flexure or disturbance within the North Branch Basin occurs at the S. foot of Coal Ridge, near the Centre Turnpike. A perpendicularly-dipping coal, shafted both E. and W. of the road, implies the proximity of a sharp crushed axis S. of it; and the existence of apparently the same coal dipping Southward at a very high angle some 300 feet further N., by indicating a squeezed basin, supports this view of a compressed anticlinal. To what distance this acute flexure extends low on the slope of the mountain we are unable to say, but it seems to have no existence $1\frac{1}{2}$ miles to the Westward, where all the coal-beds of the slope and base of the ridge have been carefully opened and proved, and where only undisturbed Southward dips prevail.

That the lower Coal-measures actually pass to the Eastward of the Catawissa Road is obvious from the materials on the surface, and from certain shaftings on two or three coal-beds in the neighbourhood of the turnpike. That the Coal-measures also rise high upon the summit of Shamokin Mountain, is a fact equally well established by actual digging along its crest W. of the road. Descending along the basin, we shall find, of course, successively higher coals basining out to meet us as we advance down the bed of the valley; but no developments have been yet made to show at what point the several lower and middle White-Ash seams have their Eastern spoon-shaped terminations. From all the data afforded by the developments made in shafting, from the gap of the North Branch in Red Ridge to Coal Run and the Shamokin Creek, we are entitled to infer that the uppermost coal-seams remaining in the centre of this synclinal belt, where the North Shamokin Creek turns to pass out of it, are those which overlie the large Coal-bed, No. VIII., perhaps as high in the series as Coal X. or XI.; that those which lie highest in the basin N. of Hornberger's are the Coals XI., XII., and possibly XIII.; and that those which we meet with at the passage of Coal Run across the basin are the Nos. XIII. and XIV. of the series. It is not practicable, in the present infancy of mining in the district, to trace the distribution of the coals in this synclinal range with any more precision.

ANTICLINALS IN THE PROLONGATION OF BASIN 9, SOUTH OF SHAMOKIN.

Four anticlinal undulations, as already intimated, occupy the width of this general synclinal belt opposite Shamokin between the leading anticlinal No. 8 and the prolongation of those of Coal Ridge. That these are in some sense subordinate to this synclinal tract or basin, must be inferred from the circumstance that they nowhere lift out the lower White-Ash coals, neither of them bringing to the surface anything deeper seated than Coal XII.

Axis A *of Basin* 9.—The first or most Southern of these flexures has its E. commencement probably about opposite Coal Run Gap, for S. dips connected with it are visible in two or three coal-beds, shafted at the N. foot of the narrow neck which separates Coal Run from Quaker Run. From this point it ranges Westward to the valley of the Shamokin through the depression between the two synclinal summits of the mass of land enclosed between the Shamokin and Coal Run, and crosses the Shamokin Valley about 400 feet S. of the Furnace. Its course Westward of the valley is between two similar knobs, the prolongations of the same synclinal basins. Indications of this axis occur about 1400 feet N. of Carbon Run, and opposite the mouth of Gerhart's Run, beyond which, though it is probably prolonged for a good distance, we have not traced it. The road from Shamokin to Trevorton probably passes for some distance along the crest of this anticlinal near the head of Carbon Run; but in the present unopened state of the district it is not expedient to state this too positively.

Coals exposed at Axis A.—The lowest coal denuded at the water-level on the arch of this anticlinal is apparently the Coal XIV. of our Shamokin series, though I would not at present be very positive in my count to within one coal. Three other seams of workable dimensions overlie this bed of the anticlinal axis, and the uppermost of these, by my estimate Coal XVII. of the basin, outcrops in synclinal manner all round each of the two synclinal ridges which bound this axis. Each basin terminates about half a mile E. of the Furnace. Of this we feel assured, inasmuch as the seam has been carefully traced by shaftings conducted by Patrick

Daly, the most skilful practical explorer of coal, by digging, in all the anthracite coal region. This anticlinal appears to subside gradually in going Westward.

Axis B *of Basin* 9.—North of the preceding about 1000 feet ranges parallel with it another shorter axis, commencing apparently W. of Coal Run, crossing the valley of Shamokin Creek some 600 feet N. of the furnace, and dying out probably Westward of Carbon Run. We only know it distinctly where the denuded valley of the Shamokin exposes it. It lifts just the same coals to the surface, though not quite as high as are brought up on the axis S. of it. This anticlinal would appear to sink Eastward.

Axis C *of Basin* 9.—The third anticlinal of the group is a considerably longer one, being traceable from near Coal Run to the vicinity of Furnace Run, W. of Shamokin. The position of this saddle is a little S. of the North-dipping openings on the uppermost coals of the Luke Fidler Tract, just N. of the Shamokin Road. Crossing from the valley of Coal Run, it goes through the narrow hill which divides this from the Shamokin Valley, and crosses the latter just 900 feet S. of the railroad bridge over Coal Run. About one-third of a mile W. of the mouth of Carbon Run the axis has been proved by shaftings nearly 300 feet S. of the Trevorton Road, but W. of the section there we have no means at present of tracing it in its prolongation. The sharpness of the flexure, however, its N. dips being 70° and its S. 45°, implies that it ranges on for some distance. This axis, in fact, evidently rises Westward.

Like the two preceding saddles, this flexure elevates to the water-level of the Shamokin Valley Coal-bed XIV. of the basin.

Axis D *of Basin* 9.—The fourth and last flexure of the group, a shorter and feebler one than the last, is that of the beautifully-developed arch just S. of Coal Run, at the town of Shamokin. Indications of it may be detected as far Eastward as the ravine of the Luke Fidler Colliery, and its influence upon the strata is conspicuous E. of the old sawmill pond on the railroad. It crosses the valley of the Shamokin Creek, and indeed appears to be three times intersected by the stream in its windings. Whether this and the anticlinal developed by coal-shaftings on Furnace Run 1200 feet W. of its mouth, are the same, is at present doubtful, since that flexure lies 200 or 300 feet too far N. for a parallel prolongation of the saddle next S. of Shamokin.

Being a feebler anticlinal uplift than either of the three preceding axes, the N. dips from it are comparatively gentle, not exceeding 30°; the S. limb of the arch, however, disappears at an angle of 60°.

The lowest coal elevated to the level of the railroad upon the summit of this arch is apparently No. XII. of the Shamokin series; possibly it is No. XIII. A careful tracing of the ground Eastward indicates this coal to be the same as the Southern or upper one of the Luke Fidler Ravine. Our cut exhibits the size and divisions of the Luke Fidler coal, so called.

Fig. 242.—Luke Fidler Coal-seam.

Looking at the configuration of all five of the anticlinal waves which cross the Shamokin stream between the mouth of Coal Run and that of Buck Run, we are struck with the accordance which prevails among them all except the most Northern, or that last described. Each is a little steeper on the N. leg of the arch than on the S.; their distances asunder are nearly equal, and they are remarkably parallel. The last of the group, however, or that nearest Shamokin, betrays the opposite law of curvature of its arch, the S. limb being the steep one, and the N. the flat. Such, too, is the form of the flexure developed in the coal-shafts on Furnace

Run. It is worthy of note, that this flattening of the N. dip takes place only in the Northern flexure, or the first one which begins to feel the influence of the general uprising of the Northern side of the basin, or the strata of the Shamokin Mountain.

When we embrace in one comprehensive view all the numerous anticlinal flexures, twelve at least in regular series, which occupy the undulated synclinal valley of the Shamokin Coal-field in the region of the Shamokin Gap, we are struck with the circumstance, that while all the Southern ones, or those which enter the long Northern slope of the Mahanoy Mountain, exhibit a progressive flattening of their Southern sides, lifted, as it were, by the general uprise of the strata of the S. side of the coal-field, the middle group observes the normal law of the Appalachian anticlinals, which is to have their Northern incurvation steeper than their Southern ; and that the Northern set, or all those which range at the base or on the flank of the Shamokin Mountain, reversing the configuration of those of the Mahanoy Ridge, have their S. slopes the steepest, and their N. ones flattened, as if raised by the opposite or S. dip of the Northern side of the great trough. This modification of the form of the subordinate flexures, by the position they occupy in the general basin, is not confined to this Western end of the Shamokin Coal-field, but prevails everywhere in the more undulated districts of the entire coal-region. I conceive it to be in the strongest manner significant of the mode of origin of these lesser undulations, which I regard not as flexures pervading the whole thickness of the earth's once flexible crust, such as unquestionably the great Appalachian anticlinals are, but as more superficial corrugations produced in a secondary manner within the wide crust-waves, by the plicating action of the lateral forces engendered upon the contraction of the area of the upper strata, by the approximation of the sides of the great troughs into which the crust was heaved.

BASIN No. 10, OR THAT OF COAL RUN AND ITS INCLUDED ANTICLINALS.

The Northernmost of the sub-basins of the Shamokin Coal-field is that of Coal Run, bounded on the S. by the complex anticlinal of Coal Ridge, and on the N. by the monoclinal crest of the Shamokin Mountain. As a distinct synclinal trough, this belt is not prolonged much to the W. of Coal Run Gap, for the disappearance of the Coal Ridge anticlinals E. of Shamokin, and the introduction of other flexures N. and W. of that town, conspire to destroy the simple basin structure which it possesses further E., and to compel us to adopt a new classification of the coal-field W. of Shamokin Gap, and N. of Carbon Run. For convenience, however, we will extend our description beyond the proper Coal Run Basin, or from the synclinal mountain-knob in which it commences N.E. of Mount Carmel, to the notch in the mountain by which the Shamokin Creek passes out of the coal-field. Thus limited, it may be defined as a straight basin about three-fourths of a mile in breadth in its central widest portion—with a gradual descent to the Westward—of a simple synclinal structure at its Eastern end—undulated in its centre, along its middle section, by a sharp straight anticlinal wave—and undefined in its Western end by any Southern anticlinal boundary.

As in similar former instances, it will be expedient, before entering on any statement of the Coal-measures found within this basin, to trace the subordinate anticlinals which occur within it, especially a long and very regular one which ranges near the centre of the trough.

Anticlinal A *of Basin* 10.—This flexure of the strata undulating the bed of the trough, which but for it would be a remarkably symmetrical synclinal wave, seems to commence at the E. near

the Centre Turnpike, and to pursue a straight course a little N. of Coal Run. Crossing our several exploratory shafts in its progress along the valley, its position has been accurately determined. Converging a little upon the Northern axis of Coal Ridge, or *b* of Axis 9, it passes N. of Coal Run Gap about 1200 feet from that axis. Here leaving the valley, it takes the summit of an irregular table-land, and afterwards the crest of a ridge into which this is prolonged, in the very point of which, and not more than a few hundred feet from the E. edge of the village of Shamokin, it displays itself in a regular arch of coarse sandstone. If it range so far, it must pass a little N. of the village. Except near Coal Run Gap, which is not far from the middle of its length, this flexure is everywhere much steeper in its Southern limb than in its Northern, the dips in the former, for some 2 miles W. of the Centre turnpike, being between 55° and 75°, while the N. dip only amounts to about 10°. So likewise, near Shamokin, the S. leg of the arch dips 30°, and the N. leg only 10°. Opposite Coal Run Gap, however, where its distance from the Northern axis of Coal Ridge is less, the influence of this is to flatten the S. dip to 20°, while the N. dip here amounts to 30°. The direction of this wave is singularly parallel with that of the crest of the mountain N. of it.

The influence of this central anticlinal in lifting the bed of the coal-basin, and in throwing out, or causing, by exposure to denudation, the loss of some of the higher coals which would otherwise have occupied the bed of the valley, is not to be overlooked, and it behoves us to ascertain, if possible, what the highest beds are which have been left to saddle over it at the lowest water-levels which intersect it. To determine this for all parts of the basin would not be an easy task, but expensive experimental shaftings, conducted under my direction, have enabled me to ascertain that, in all probability, the axis north of Coal Run Gap just lifts to the crown of the hill, through which it passes, the Coal X. of the basin. But whether or not precisely the same part of the Coal-measures is exposed all along to the Eastward is doubtful, since a mere difference in the steepness of the flexure, and therefore in the depths of both the subordinate troughs into which it divides the basin, may make a material difference in the number of coal-beds preserved or washed away through its agency. I believe, however, that very nearly the same Coal-measures will be found to range along this axis throughout almost its entire length from W. of the Turnpike to Shamokin village.

Axis B *of Basin* 10.—Another secondary anticlinal, originating at the base of the Shamokin Mountain N.E. of the village, lies about 600 feet N. of this last. This flexure is distinctly to be seen on both sides of the Southern entrance of Shamokin Gap, where the bridge crosses the stream, there forming a beautifully-regular low arch in the coarse sandstone and Pea-conglomerate which overlies the Coal X. or XI. of the basin. It is indicated, likewise, on our main Shamokin Cross Section, 1000 feet or so N.E. of the upper edge of the village. Beyond this, to the Eastward, it seems by its bearing to encroach slightly upon the flank of the mountain. Between the village and Shamokin Gap, we may perceive, in the steepness of the hill-side N. of the road, the influence of this axis on the topography. How far to the Westward of the gap this flexure extends I have at present no data for determining, but as the flexure is a gentle one, we may infer that its length is not great.

The reader will be much assisted in following the foregoing description of the numerous secondary anticlinal flexures and basins of the Shamokin Coal-field, by consulting, at the same time, the Map of the coal region, and the 5th and 6th Sections on Plate IV., or that through Shamokin, and that across the head-waters of Gerhart's Run.

DESCRIPTION OF THE COAL-MEASURES IN COAL RUN BASIN AND AT SHAMOKIN GAP.

The fine natural section, rendered still clearer by mining, of the Shamokin Gap, a cut of which is here presented, illustrates well the Coal-measures of the Shamokin Mountain and the Coal Run Basin.

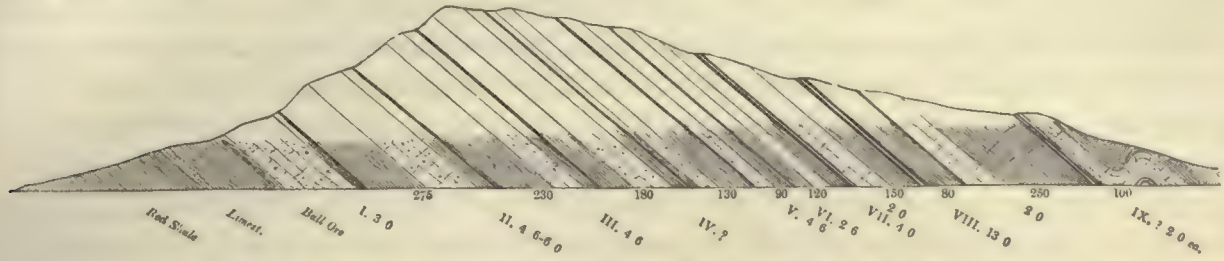


FIG. 243.—Section of Shamokin Mountain at Shamokin Gap, looking E.—1 *inch* = 400 *feet*.

The productive Coal-measures in this basin appear to begin on the E., in the very summit of the synclinal knob in which the basin terminates, and the first or lowest coal of the conglomerate series occupies the crest, or even a bench, high on the N. slope of the Shamokin Mountain, for the chief part of the distance to the Shamokin Gap. Coals have been shafted in these positions just W. of the summit-level of the Centre Turnpike. The same lower coals, or those within the coarse conglomerate, must outcrop on the broad summit of Coal Ridge for a distance to the E. of the turnpike; but the more productive, or middle and upper Coal-measures, as already intimated, first saddle the crest of the mountain about half a mile to the W. of the road. The 2d coal-seam generally outcrops in a bench either on the very crest of the mountain, or just a little S. of it, the 3d in another bench usually very high on its S. slope, and the 4th and 5th in terraces still lower down. All these coals lie between massive strata of the coarse conglomerate rock, of which the main body and crest of the Shamokin Mountain consist.

Coal No. I. is nowhere more than 2½ feet thick; Coal II., where opened, contains in some places 6 feet of coal; and Coal III., about 125 feet S. of it, contains, with a thickness of 8 feet, often 6 or 7 feet of good coal. Coal IV., at a distance of 100 feet S. of the last, exhibited in the shafts opposite Coal Run Gap a thickness of 6 feet, and promised to yield about 4½ feet of coal; while Coal V., distant from the Coal IV. only 75 feet, with a dip of 45° to the S., showed a thickness of 2½ feet at the points where it was best exposed. Nearly all these beds, apparently in full development on our Sections N. of Coal Run Gap, are more or less crushed by mechanical pressure at the gap of Shamokin Creek further Westward. Comparing this group of five coals within the Seral conglomerate, we may either regard the lowest, or No. I., as the equivalent of the outside coal of Trevorton or Zerbe's Gap, called O of that series; or we may consider the small 5th seam as an additional upper coal entering the conglomerate group Eastward of the Shamokin Gap, and suppose the O of Trevorton to thin out altogether before coming so far E.

Ascending in the series, the next group of coals consists of those which overlie the coarse conglomerates of the mountain, which are limited upward by a well-marked little conglomerate stratum of small pebbles. This group generally embraces about four workable seams, and in all six coals of notable size. The lowest of these usually have their N. outcrops, or the N. limits of their special basins, at the S. foot of the steep slope, or upper part of the mountain; in other words, at the upper limit of the long inclined plane which rises from the bed of the valley to the first abrupt acclivity of the ridge; each such outcrop is indicated by an obvious depression or

shelf upon the side or at the base of the mountain. Descending into the bed of the basin, these upper coals, or those of the softer Coal-measures, probably six or seven in number, where the whole are present, rise again in the anticlinal flexure of the middle of the valley, the upper ones cropping out, and the lower ones arching the axis. Taking another dip, they trough themselves a second time in the S. or immediate valley of Coal Run, to rise a second time in the N. flank of Coal Run Ridge, either to outcrop there, or to saddle in turn the axes of that mountain, according to the part of the basin across which we trace them. These coals do not appear above the water-level of Coal Run in the gap at the W. end of Coal Ridge, for the little conglomerate surmounting them there forms the interior stratum of the flat anticlinal arch. To the Eastward they rise and lap over the axis or outcrop on both slopes of the ridge. They may be reached by the ordinary method of mine slopes, by stationary power, for a distance of some 3 miles Eastward from Coal Run Gap. The middle large coals of this group, No. VIII., for example, outcrop on the summit of the Anticlinal Mountain, probably between our Sections No. 4 and No. 3 of the Coal Run series. The lowest coal of this middle group, the equivalent of No. V. of the Trevorton Scale, outcrops at the foot of the upper steep declivity of the Shamokin Mountain, while on Coal Run Ridge it lies saddled over by the beds above it, until we reach the neighbourhood of the Centre Turnpike, where it comes out to the day near the anticlinal axis. It is probable that this bed does not basin out Eastward in the valley, until we reach a point a mile at least E. of the turnpike.

The next large coal of the group, No. VIII. of the whole basin, containing about 6 feet of good coal at the points where it has been proved or mined, is one of the productive beds at the Shamokin Gap. To this succeeds Coal IX., apparently the Twin Coal of Zerbe's Gap. In the basin before us this is in reality two coals, divided by an argillaceous sandstone or hard sandy shale, varying from 15 to 18 feet in thickness; the lower bed at the Shamokin Gap being 6 feet thick, while the upper is usually about 7 feet; but N. of Coal Run Gap the upper bed has 8 feet of coal in the shafts, and the lower about 3 feet. These dimensions are the smallest under which this double coal usually presents itself, and in the basin South of the Coal Run Valley it has in some places 14 and even 20 feet of total thickness of coal, with a dividing rock thinned down to only a few inches of slate. On the Sunbury Railroad E. of Shamokin, and therefore S. of the Coal Run Basin, the coal-seams VIII. and IX. have their dimensions and divisions shown in the annexed cut.

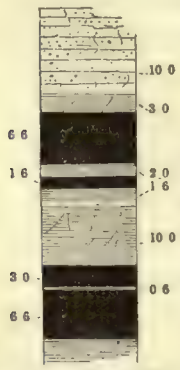


Fig. 244.—Coals VIII. and IX. on Sunbury Railroad E. of Shamokin.

The upper or third group of coals, or that which overlies the so-called little conglomerate, embraces, where the formations are fullest in the coal-field, about five seams, of a thickness of 3 or more feet each; some of these take their place in the middle of the Southern trough of the Coal Run Basin, or that between Coal Ridge and the anticlinal axis of the middle of the valley; but they cannot ascend the basin Eastward any considerable distance beyond where they have been shafted on and proved, between our Cross Sections Nos. 2 and 3 of Coal Run, or perhaps a mile above Coal Run Gap. The lowest beds of this group arch over the flat anticlinal of Coal Run Ridge at Coal Run. The upper seams pertain probably to the base of the Red-Ash Coal-measures of the Pottsville Basin, and the lower ones are on the horizon of the Grey-Ash coals. It would appear that there are in all, in the deeper parts of the Coal Run Basin, at least some fifteen or sixteen coal-seams of notable

dimensions, more than half of which are of a size and quality fitting them to be extensively mined.

Estimate of the Coals in Coal Run Basin.—The Coal Run Basin has a length of rather more than 4½ miles, and an average breadth, measured from the anticlinal summit of Coal Run Ridge to the crest of the Shamokin Mountain, of about 4500 feet. In estimating the extent of each separate coal-bed within this basin, it must be borne in mind that those which are undermost in the strata occupy the whole of this breadth, and range lengthwise along its entire course. Each of these, therefore, fills an area of at least 3 square miles. The other coals, which are higher in the series, are somewhat more circumscribed as respects both the breadth and the length of the troughs which they form, for, reposing in concentric basins, their outcrops or margins lie successively nearer and nearer the bed of the valley. Nevertheless, I am disposed to compute the average areas of the large coals which next overlie the conglomerate series of the mountain at not less than 2½ square miles. These have their Northern outcrops close under the base of the steep flank of the Shamokin Mountain on the one side of the basin, while on the other, in Coal Run Ridge, they spread to the anticlinal itself, excepting only where this lifts to the surface the mountain conglomerate in the vicinity of the central turnpike and Eastward. As to the space occupied by the upper coals—namely, those exposed in drifts and shafts in the gap of Coal Run Ridge, near the anticlinal—a careful tracing of their outcrops or edges clearly shows that these, in their turn, cover an area of at the least 1½ square miles.

Combining with the foregoing elements of area or superficial extent, a review of the available thicknesses of the several coals, it will be easy to frame a very reliable approximate calculation of the quantity of coal contained in each bed or group of beds, and compute with some precision the total amount embraced within the whole basin.

In passing to the consideration of the dimensions of the various coal-beds of this basin, I wish it to be distinctly known that the measurements here given relate to the good or available coal which they contain, as deduced from a comparison generally of several or even many openings made on each seam at distant points.

To present the full thicknesses of the beds without adequate reduction being made for the slaty coal, slate, and fireclay generally contained in more or less amount in all our anthracite seams, is to commit a serious and unwarrantable exaggeration. Adopting the ascending order, we begin with

The 1st Coal.—This seam has its outcrop near the very crest of the Shamokin Mountain, being the lowest of the conglomerate series. As exposed by shafting, it is about 2½ feet thick, and may contain 2 feet of good coal.

Though it underlies the entire basin, and may very possibly expand in some localities to more profitable dimensions, I shall exclude it altogether from my estimate of the workable coal. The next discovered bed, which I shall call

The 2d Coal, is a mass of excellent fuel, measuring between its fireclay floor and its roof of slate about 7 feet. It contains, where it has been opened, 6 feet of marketable coal. This bed has its N. outcrop on the brow of the mountain, and underlies the whole extent of the basin.

The 3d Coal outcrops on the next conspicuous bench or terrace on the S. flank of Shamokin Mountain, about 125 feet further S., and basins with the other conglomerate coals, the two below it, and the two above it, under the whole breadth and length of the Coal Run Valley, and also the

valley of the North Branch of Shamokin Creek. This coal, on Shamokin Mountain, measures 8 feet between a floor of fireclay and a roof of slate, contains a dividing-slate of not 6 inches in thickness, and possesses as much as 7 feet of good coal.

The 4th Coal has its outcrop on the Shamokin Mountain, usually about 75 or 100 feet S. of the 3d, and on a less conspicuous bench. It there shows an average thickness of about 6 feet, but usually contains a thin band of slate, and frequently a layer of rough and slaty coal, which reduce its available productiveness to about 4½ feet. On the most Western line of shafts, near the outlet of Coal Run, it exposes a thickness of 7 feet, and of this 6 feet is fair coal. I shall count it at 4½ feet.

The 5th Coal is distant from the 4th not more than 75 feet, dipping 45° to the S. with the rest. It holds a slightly lower depression on what may be viewed as the terrace of its companion, the 4th. It is only 2½ feet thick at the points where it has been best exposed, and though probably larger in some localities, is not of such size or quality as to warrant its admission into our present careful estimate of productive quantity.

All of these coals lie between beds of the conglomerate rock, which form the main mass and crest of the Shamokin Mountain, and the interior of Coal Run Ridge, and, indeed, the general base of the whole coal-formation. In the region of Zerbe's Gap, near Trevorton, this division of the Coal-measures exposes four of the five coals here described, in perhaps their maximum dimensions, for they are there from 6 to 11 feet in thickness throughout a distance of several miles. The same four beds appear to be squeezed, at Shamokin Gap, by the mechanical pressure which attended the uplifting of the strata; but E. of that probably somewhat dislocated portion of the mountain, where the excavating waters made their breach, these coals resume their regular or natural size, approximating to that exhibited in the more W. tracts of the basin.

The small fifth seam of the present enumeration appears to be an additional coal, which enters the conglomerate group E. of Shamokin Gap.

Assigning to them their truly available thicknesses, we find them to contain the following quantities of coal per acre:—

The 2d Coal of the series, with 6 feet thickness of good coal, will yield	10,000	tons per acre.
The 3d Coal, computed at 7 feet of good coal, will afford, say .	11,500	,,
The 4th Coal, counting it at 4½ feet, ...	7,500	,,

Making a total product of 29,000 tons per acre from the three seams.

Calculating from these data and their average areas within the basin, I find their total amount in coal to be equivalent to more than 42,000,000 of tons.

The whole of this vast quantity is not, however, to be considered as available for profitable mining. Though no portions of these beds descend to a depth which is not economically accessible even at the present day, yet a certain amount of their coal will inevitably be irreclaimable from the presence of irregular local undulations in the strata squeezing and nipping out the coal, or rendering it unfit for the market. All experience teaches that, after adding to this source of waste that which attaches to the present imperfect method of coal mining, by which a portion, more or less considerable, of otherwise good coal is left in the mines, or destroyed for use, a reduction of not less than 33 per cent will arise on the total quantity of good fuel in every such constructed coal-field. The basin before us promises to present but few faults, and as large a

proportion of sound coal as the soundest basins of the anthracite region ; yet some bruised coal must occur where the strata dip as steeply as 45°, which is about their highest inclination on the flanks of the valley.

We come next to the set of coals immediately above the conglomerate series. These, if we divide the whole formation, as here developed, arbitrarily into three parts, form our second group, for which I propose the main conglomerate mass as the lower limit, and an overlying thinner conglomerate of small pebbles as the upper. The part of the coal strata between these two horizons includes, in the district before us, as many as eight separate beds of coal, four of which are usually of large dimensions, and two others generally of such size as to admit of economical mining. The outcrop or rise to the surface on the N. side of the basin is at the inner or S. foot of the steep slope or upper part of the Shamokin Mountain ; that is to say, at the upper limit of the long-inclined plane which extends from the bed of the valley to the first abrupt acclivity of the ridge. The place of each is marked by a separate and discernible, though, to an unpractised eye, not an obvious depression in the ground.

Dipping thence under the bed of the valley of Coal Run, they reascend on its S. side, and take their places on or in the N. flank of Coal Run Ridge. These coals do not appear above the water-level immediately at the gap near the W. end of Coal Run Ridge, inasmuch as the little conglomerate which surmounts them forms the interior stratum of the anticlinal arch at that place ; but E. they rise successively, and lap themselves over the axis of the mountain without emerging to the surface, while still further in the same direction they come forth to the day one after the other on the very crest, and there each parts into two outcrops, one to take its appropriate terrace high on the S. flank, the other a similar bench on the N. These middle large coals thus emerge on the summit of the mountain between Section No. 2 and Section No. 5, a space of about 3½ miles, throughout which they are all accessible, and have high working breasts.

They can be easily entered, especially on the N. side of Coal Run Ridge, by a short tunnel penetrating Southward low on the slope of the hill ; and when opened in that way, will each present a very long and increasing breast of coal, dipping at not more than an average inclination of 45° Northward into the Coal Run Basin ; or they may be very successfully commanded by the ordinary mode of slope-working, with stationary power at their outcrops on either side of the valley. Their distance below the surface, even in the centre of the basin, is not great. I question if it exceeds 400 feet in favourable spots. Their position at so moderate a depth, and their gradual dip from both sides of the valley to the centre, and also longitudinally for several miles towards the outlet of the valley, are features which strongly suggest the expediency of mining these beds of coal by a vertical shaft in the manner of the larger European collieries. The proper situation for a pit intended as an outlet to this middle series of coals, would be somewhere in the middle of Coal Run Valley, a mile or more to the Eastward of the gap, where their Eastward rise brings them to an easily-penetrated depth beneath the surface. Such a pit would not perforate any beds of resisting conglomerate, but would pass through soft shales, and the readily-drilled sandstones separating the coals.

I know of no spot in all the anthracite fields of Pennsylvania where a colliery on a colossal scale, upon this only efficient plan for a large and concentrated mining enterprise, could be more economically erected. A single pit of altogether manageable depth could be made to command and drain each concentric basin of three or four large coal-seams, from their lowest points upwards

to their outcrops on *both sides* of the valley, and Eastward for 3 or 4 miles to the running-out lengthwise of each of their superposed troughs. This desirable method of winning the coal on the few large estates which offer the requisite facilities in the geological position of their coal-beds, is only to be undertaken by such as are willing to invest a fair amount of capital at the outset; but if judiciously organised, must prove, I am very confident, by far the least precarious, most easily conducted, and most permanently profitable of any known methods of mining adaptable to our coal-fields.

The lowest coal of this middle group, the *6th Coal* of our present enumeration, called Coal No. V. in the Trevorton portion of the general basin, has its outcrop in the Coal Run Basin at the foot of the first steep declivity of Shamokin Mountain, and lies high in the interior of Coal Run Ridge, on the very crest of which it rises out to the day in the neighbourhood of the central turnpike. It follows the Coal Run Basin to its E. extremity one mile at least E. of the turnpike. It occupies, therefore, an area of considerably more than 2½ square miles, or 1600 acres. Its average thickness is between 10 and 12 feet. On the slope of Shamokin Mountain, one mile E. of Coal Run Gap, it measures 11 feet, and contains less than 1 foot of slate and impure coal. The rest of the bed is excellent coal. On the summit of Coal Run Ridge, one or two miles further E., its size is about 10 feet; and one mile E. of Mount Carmel, the same coal has a thickness of 12 feet, and is very pure. I am therefore perfectly within bounds in assigning to this seam 9 feet of marketable coal, or 15,000 tons per acre for all that part of the basin which it underlies.

The *8th Coal* of the formation, though containing about 6 feet of coal at Shamokin Gap, where it is mined, has been less thoroughly explored than the other large masses, and I hesitate to assume it as yielding generally 6 feet of merchantable fuel. There can be no doubt, however, that its average product will exceed 4½ feet, or 7500 tons per acre.

The *9th Coal* of the formation in the Coal Run field, the Twin Coal of the Trevorton end of the region, is here, as very generally it is elsewhere, an admirably pure coal, and of large dimensions and great persistency of quality and features. In the locality now under review it is properly two coals, separated by a stratum of sandstone or sandy shale of from 15 to 17 feet in thickness. The lower bed has at Coal Run Basin the size of 9 feet, and contains 8 feet of excellent fuel; the upper is 4 feet thick, and may be relied on for a 3-feet thickness of good coal, giving the Twin mass 11 feet of available material; but I am disposed to rely only on the large bed, whose contents are equal to more than 13,000 tons per acre. The dimensions here cited are the smallest under which this bed has been found. Developments made in some places, especially in the basin S. of Coal Run Ridge, and in that S. of Red Ridge, exhibit a coal identical in all probability with this one, but materially thicker. The bed referred to has been opened on the M^c^Call Lands, one mile E. of Mount Carmel, making a display of 22 feet of material between the roof and floor, with only 7 inches of slate in it, and 8 inches of inferior or bone coal. It there contains more than 20 feet of excellent anthracite.

I refrain from presenting at the present time any estimate of the fourth main coal of the middle group, as this seam has not been yet sufficiently identified and traced to furnish the elements of an accurate and safe calculation. Though in many localities a stratum of noble dimensions, it is somewhat inconstant in size, and is apt to subdivide itself by including slate and other materials.

Rejecting also for the present the four remaining smaller beds of this series as not susceptible, until better explored, of very precise determination as to their amounts of available coal, I shall pass on to consider the chief seams of the higher or third division of the formation, or that part which overlies the so-called Little conglomerate.

In this group we have established, as already indicated, the existence, and traced with more or less accuracy, the outcrops of five coal-seams of 3 feet and more in thickness, and there are reasons for admitting one or two other beds of workable dimensions into the series. The coals now before us take their place for the chief part in the valley. In Coal Run Basin, the upper seams spread themselves with gentle dips from both sides under the broad and nearly flat bed of the Western portion of the valley. These are chiefly, if not all of them, Red-Ash coals. The lower beds of the group ascend the flanks of the anticlinal ridges where these are low or subsiding, and there arch themselves over their crests in bold and regular anticlinal curves. Such is the attitude held by the two largest and lowest of the series at the three several anticlinal notches—that of Coal Run Gap in Coal Run Ridge, that of Shamokin Creek in Red Ridge, and that of the same stream in Jamie's Ridge. At each of these points these two important coals present themselves on the two opposite flanks of the ridges, offering the easiest conceivable access to fair and even ample breasts of coal above the water-level. As the higher beds are of inferior size, and of more restricted areas and less lifted position, I shall confine myself, in the present description and estimate, to the two lower ones before us.

The first in ascending order, resting at an interval of seldom more than 20 feet above the little conglomerate, which divides this inferior from the middle group of coals, is an admirably pure and clear coal, of very ample dimensions. It is about the 13th bed of noticeable size in the coal-formation. In the W. end of the Shamokin Basin, where it is the highest coal there preserved, it frequently exhibits a total thickness of 6 or 7 feet, but it is there usually divided by a layer of sandy shale or sandstone, a foot or two in size. Eastward from Shamokin, the proportion of good coal in it seems to augment, for at Coal Run Gap it contains, in a thickness of 7 feet, more than 6 feet of fuel of a quality unsurpassed, and in the middle and Eastern districts of the Coal Run and North Shamokin basins a considerably greater amount. In the anticlinals of Red Ridge and Jamie's Ridge, at the passage of the North Branch of Shamokin Creek through them (see the wood engraving, fig. 241), this excellent bed attains the size of 14 feet, and, holding about this magnitude, it follows both flanks of each of these ridges, and gradually rises to the Eastward in the two basins which these ridges and Coal Run Ridge include between them. Of this coal a very ample proportion holds a position above the water-levels of the gaps already mentioned as intersecting it. It can there be entered endwise, and mined Eastward and Westward on both the N. and the S. dips of the anticlinals, making, in fact, at each of these three natural inlets to it, four separate collieries of more than the average scale of productiveness, susceptible of ready expansion in future years by the method of underground slope-pits. I will not at present pretend to offer a calculation of the total quantity of good coal in this valuable seam, nor even of the large quantity accessible above the lowest water-levels at the bases of the hills into which it rises, but I am able to produce a pretty safe approximate estimate for the Coal Run Basin and the W. end of Coal Run Ridge. The extensive researches undertaken in quest of this coal, and its companion seam above it, by lines of shafting across the Western end of the basin, and over the flanks and crest of the ridge, permit me to estimate with confidence its minimum ascertained thickness of pure

coal at about 6 feet in Coal Run Basin and Ridge. We have here not less than Ten Millions of tons of excellent anthracite.

The next and last coal to which I shall specially refer, the 14th Coal of our general series, overlies that above described at an interval of about 50 feet. Like its lower companion, it is a beautifully pure mass of fuel, but its prevailing thickness is less than that of its mate. At the gap in Coal Run Ridge it measures in all 6 feet, and may be estimated as yielding throughout the region 4½ feet of good coal. It admits of the same facilities in mining which belong to the larger coal near it, rising in extensive breasts above the water-levels of the country. Occupying about the same area, say, in the basin and ridge of Coal Run alone 1000 acres, of which an extensive portion can be reached without a shaft, or slopes, or even a tunnel, and indicating an average product of certainly 7500 tons per acre, it promises to contain not less than 7,500,000 of good fuel, and to afford by mining a nett yield of fully 5,000,000 of tons from the one district here designated. These two coals, thus defined, seem to constitute the uppermost of the main workable beds of the true White-Ash class in this part of the Shamokin coal-region. Above them in the series we soon enter a group of beds, which furnish pinkish-grey and red ashes. Two or three of these occur in the middle of the Coal Run Basin, and are to be met with in the other deeper tracts of the coal-field; but as their limits have not yet been traced with the requisite precision, I refrain from attempting a description of them. While the coals here described are as easily ignited as the chief part of the free-burning Red-Ash class are known to be, they possess the very important superiority for the leading uses to which anthracite is applied as a fuel, of producing a comparatively infusible white ash, thus exempting the furnace-grate from the large share of clinker or stony slag which is so mischievous in a strong fire of Red-Ash coal. These coals ignite readily, and consume very rapidly under a sufficient draft. This adapts them well for all purposes of speed and power: while some of them are sufficiently firm to take any shape, and to bear the roughest handling, other beds are unprofitably soft or tender. They are, as already intimated, 3 feet and more in thickness.

Thus we learn that there are in all some seventeen or eighteen coal-beds of notable dimensions in the coal-field E. of Shamokin, and that eleven or twelve of this number are of such magnitude and average soundness as to warrant confident anticipations of their fitness for mining. Of these, four or five are of a bulk and excellence not generally met with.

CHAPTER II.

STRUCTURE AND CONTENTS OF THE COAL-FIELD BETWEEN SHAMOKIN GAP AND THE WESTERN EXTREMITY OF THE BASIN.

THAT portion of the coal-field which lies between Carbon Run and the crest of the Mahanoy Mountain having been already illustrated in detail, I proceed now to take up, in continuation of the central and Northern basins, the district which is occupied by Carbon Run. It extends from this stream to the crest of the Shamokin Mountain. Of this valuable portion of the coal-field extremely little is specifically known, in respect either to its structure or its coal, no portion of it,

except that bordering on the Shamokin Creek, having been as yet explored by any systematically-organised surface-shafting, or by mining. Even its subordinate flexures, the tracing of which can only be effected through a well-conducted opening of its coal-beds, remain to be discovered and located. I must therefore content myself with a meagre and general description of all this tract. Passing the summit of the watershed which separates Carbon Run from Zerbe's Run, we enter upon ground which has been extensively and successfully explored, and from this point to the end of the basin, a distance of some 5 miles, a very satisfactory picture can be given of its interesting structure and its vast resources.

The N. half of the coal-field, or that which lies between Carbon Run and the summit of the Shamokin Mountain, is evidently traversed, like the district intersected by the Shamokin Creek, by several anticlinal flexures, the prolongations of those which are so conspicuous further E., and which are indicated on our main Section through the village of Shamokin. These undulations are not traceable in detail W. of the meridian of Shamokin Gap, as this district has not as yet received much development : but it is apparent that the second, fourth, and fifth anticlinals S. of Shamokin extend a considerable distance into it. It is obvious, however, that some of the half-dozen axes which pass into this side of the coal-field W. of the Shamokin Creek expire before they reach the sources of Carbon Run, where the structure of the basin is manifestly more simple. It would appear that these Northern undulations maintain an average direction very nearly parallel with the crest of the Shamokin Mountain ; they must therefore converge at a very acute angle upon the Mahanoy Mountain, as they pass the watershed of Carbon Run, precisely as we have already seen those S. of that stream run into this ridge. At the watershed which divides Carbon Run from Zerbe's Run, the general basin contains apparently only three anticlinal axes, some of the others having died away, or one or two of the more Southern ones having smoothed themselves out into the N. dips of the S. side of the basin. Passing the meridian of Zerbe's Gap, we discover that the most Southern of these three has thus disappeared on the N. slope of the Mahanoy Mountain, so that the narrow end of the basin, or that watered by the West Branch of Zerbe's Run, presents but two undulations, until at last, towards the Western source of that stream, the more Southern of these two remaining ones flattens away in a similar manner as it draws near the Southern Mountain, leaving the N. axis alone to approach the head of the basin, which it does not reach. It would thus appear that every one of the anticlinals of the Shamokin Coal-field, some fourteen in number at the least, where Buck Run and the Shamokin intersect the valley, either runs into the N. flank of the Mahanoy Mountain, or dies away within the basin while converging towards it.

The coal-seams N. of Carbon Run have nowhere been fairly shafted on or opened for mining, except at a locality between that stream and Furnace Run, a little W. of Shamokin Gap ; there the Coal-measures have been carefully explored in the Sub-basins *a*, *b*, and *c* of Basin 9 ; and it has been ascertained that the top bed identified is the sixteenth in the ascending series, or the third above Rosser's Vein, which appears to be the thirteenth. Several of these coal-seams are of ample thickness for mining, and some of them, notwithstanding a prevailing steepness in the dips, give promise of being profitable.

COAL-BEDS ON THE SCOTT AND HUNTER TRACTS SOUTH OF CARBON RUN.

These lands are situated W. of Mowray's Run on the N. slope of the Mahanoy Mountain, and are traversed by the anticlinal No. 7, and the subordinate flexures N. and S. of it. A correct notion

of the general condition of the coals which they contain, their undulations, and rapid alternations of dip, may be had from an inspection of the two printed Sections illustrating the corresponding part of the coal-field on Gerhart's Run and on Buck Run. (See Section from Shamokin to Locust Mountain.) This portion of the S. side of the coal-field (and the remark applies to the whole belt as far W. as the source of Carbon Run) is composed simply of six or seven slender parallel troughs of the coal-strata, embracing a greater and increasing depth of the formation from the top of the mountain down its long flank to the bed of Carbon Run, each individual trough rising W., and gradually flattening or losing itself in the prevailing N. dip of the strata towards the summit. West of Mowray's Run, the total ascent from the bed of Carbon Run to the summit of the mountain, which is a distance of nearly one mile, is about 790 feet.

The coal-seams experimentally opened by shaftings in this neighbourhood, at the date of our observations (1854), were eleven in number, and three of these are of important thickness. The thinnest of these workable beds, No. V. of the general series of the Shamokin Basin, is from $4\frac{1}{2}$ to 6 feet thick when regular; the next large bed No. VIII. contains, when regular, about 9 feet of good coal; and the third important seam, or Coal IX. of the series—the Rennie Coal of Zerbe's Gap—is not less than 18 feet thick.

The coals of this part of the coal-field belong to the class of soft White-Ash anthracite, intermediate in specific gravity and hardness between the denser and firmer coals E. of Shamokin and the free-burning semi-anthracites of the district of Zerbe's Gap. Like these latter Western coals, they are intersected by numerous fine planes of cleavage, giving a tendency to subdivide while kindling. The coal of this district contains on an average from 5 to 7 per cent of volatile matter, 3 or 4 per cent being inflammable gaseous matter, contributing to the rapid kindling of the fuel.

WESTERN END OF THE BASIN, OR THAT WATERED BY THE EAST AND WEST BRANCHES OF ZERBE'S RUN.

This terminal portion of the basin is a little more than 4 miles long at the source of the East Branch of Zerbe's Run; its breadth, from the crest of the Locust or Mahanoy Mountain to that of the Shamokin Mountain, is nearly $1\frac{3}{4}$ miles, but the trough contracts very regularly to its W. extremity by the converging of the two mountain-barriers. Its whole form is slightly curved, even the S. barrier bending gently Southward in its progress Westward; the N. one deflecting in the same direction more conspicuously. The Eastern widest half of the district, watered by the East Branch of Zerbe's Run, has its deepest depression on the immediate valley of that stream towards its N. side at the foot of the Shamokin Mountain, and not in the middle of the basin, which is a rather broad and elevated table-land, presenting a good height of breast in its coal-seams above the water-level of Zerbe's Gap. This elevation of the centre of the valley is due chiefly to the influence of the central anticlinal flexure of the basin. West of the meridian of the gap the surface of the valley is more symmetrically trough-shaped, a feature which it owes to the flattening away of the undulations in its interior, and the greater predominant influence, therefore, of the synclinal dips from its two borders.

The general structure of this part of the Shamokin Basin is very simple. The strata of the summit and N. slope of the Locust Mountain dip Northward with an inclination which

increases as they range towards the Westward, from a slope of 60° opposite the watershed E. of Zerbe's Run to one of 70°, or even 75°, at the W. extremity of the basin. Those of the Shamokin Mountain—the N. border—dip S. also at a steep angle; but, contrary to the inclinations in the S. barrier, they flatten off more and more as they approach the W. end of the coal-field, being at the watershed of the valley as highly inclined as 60°, subsiding to 50° in crossing Zerbe's Gap, and thence, in their progress Westward, sinking steadily to 40°, 30°, and probably 20°, until, at the elevated end of the valley, all the strata swing round with about this dip, and join their steeply-inclined counterparts of the S. side of the trough. This W. end of the basin is drained centrally by the West Branch of Zerbe's Run, from the lower part of the valley of which, or, better still, from the main stream itself at a still lower level, a tunnel might be cut Southward intersecting all the coals of the central and S. side of the coal-field. The deep cleft in the Shamokin Mountain, named Zerbe's Gap, offers an admirably convenient inlet to the coal of all the N. border of the basin, giving immediate and cheap access to the entire suite of the coal-beds which there outcrop at a steep angle in both slopes of the notch, where some of them are now actively mined, being entered endwise by drifts and even counter-levels above the water-level of the gap. From this point much of the coal above this low level can be extracted from the slope of the Shamokin Mountain, and indeed no small portion of the whole field of coal above the same level, lying W. of the notch, can be thus ultimately reached without the aid of either tunnel or slope; for as the levels or gangways penetrate further W., the bottom of the whole basin rises to reach them, and a greater and greater proportion of the basin of each coal-bed presents itself between the water-level and its outcrop on the mountain, the length of each upper breast being much increased also from the twofold circumstance of the progressive flattening of the dip and the actual rise in the outcrop of each bed.

Coal-seams in the Zerbe's Run, or Trevorton District of the Shamokin Coal-field.—This portion of the Shamokin Coal-field having been carefully and systematically explored through the enterprise of the parties owning the land, who placed at the disposal of the Author workmen for the development of its coal-beds, a more than usually full account can be given of the Coal-measures and valuable seams of fuel which they include. Calling the attention of the reader to the two Sections of the coal-field, representing the strata at Eyster Gap or Zerbe's Gap, near Trevorton, I proceed to offer a concise account of the Coal-measures and their contents.

The Zerbe's Run and Shamokin coal-lands lie in the W. portion of the great Shamokin coal-basin, having their W. boundary within about 3 miles of its termination, in a line which passes nearly N. and S. through the deep water-gap of Zerbe's Run. This coal-field therefore adjoins that of the Mahanoy and Shamokin Improvement Company, and shares with it the privilege of the natural outlet and deep water-level conferred by this mountain-notch on this part of the basin. It includes the whole breadth of the coal-valley, from the summit of the Big or Shamokin Mountain to that of the Mahanoy Mountain, the lands extending, indeed, into the outside Red Shale valleys on either side. In an E. and W. direction the property has a length of about 1½ miles, and its average breadth is just 2 miles. The part which is embraced in the coal-basin possesses an average breadth of 1½ miles, its length being also 1½ miles. Another estate, that of the Mahanoy and Shamokin Improvement Company, embraces the entire breadth of the Western end of the Shamokin Coal-basin, from the Water Gap of Zerbe's Run, to the junction of the Big

and Mahanoy mountains at the termination of the coal-basin. These two estates occupy about 4 miles of the coal-field.

The geological structure of the coal-field is regular and simple, while it is such as to place the coal in positions highly advantageous for economical mining operations. On the N. and S. sides, the strata containing the coal-beds ascend to the crests of the respective mountains. Dipping inward as respects the coal-valley at angles varying from 45° to 60°, the successive sheets of coal penetrate in a leaning attitude the entire depth of each of these bounding ridges. But instead of meeting under the middle of the valley in a simple trough or single basin, the strata, soon after passing below the foot of each mountain, reascend to form an arch or convex curve in the central belt. Each layer of rock and bed of coal, therefore, if traced in its course from one mountain to the other across the basin, exhibits a broad undulation, consisting of two deep synclinal flexures and a central anticlinal one, or two lateral troughs and an intermediate arch. The arching of the strata in the middle of the valley, causes this part of it to be occupied by a broad and rather elevated ridge. Between the N. base of this ridge, and the S. foot of the Big Mountain is the synclinal valley of Zerbe's Run, while between its S. slope and the N. foot of the Mahanoy, or South-bounding mountain, the other synclinal zone has not the surface of a valley, but is an elevated flat table-land connecting the base of the mountain with the brow of the ridge. The double flexure of the strata, and the configuration of the surface here described, are features admirably suited for affording a cheap and ready access to a very large amount of coal. It admits, in fact, of a double set of collieries, where otherwise, had it the structure of a simple trough, the basin could contain but a single series. The same bed of coal presents four breasts for mining, in place of two, and fills the middle of the coal-valley with a number of easily-penetrated coal-seams ascending above the water-levels, where, under the other feature, these would have been buried several hundred feet beneath the bed of the valley.

The deep position of the valley of Zerbe's Run, at the inner or S. foot of the Northern Mountain of the basin, and the very low relative level of the mountain-notch, the natural outlet of this valley, give us control of an enormous amount of coal above the water-levels of the surface. The vertical height of the mountain-crests on both sides of the basin, in the vicinity of Zerbe's Gap, is about 450 feet, but the elevation increases as we recede. The Central Anthracite Ridge, and the table-land to the S. of it, have an elevation above the water-level of Zerbe's Run of from 200 to 300 feet. The mountains will therefore afford breasts of coal averaging from 600 to 700 feet in height, and the central tracts of the valley, breasts varying with the dip from 300 to 700 feet.

The coal-field thus defined contains an uncommonly large amount of coal per acre ; indeed, in this respect it rivals the richest in the whole compass of the anthracite country. It derives this extraordinary wealth from a combination of unusual and very favourable features in the coal-formation. The most important and influential of these is, the presence of large and valuable beds of very pure coal in the great underlying conglomerate, a part of the formation which, in nearly every other neighbourhood, contains either no coal at all, or only one or two beds of inferior quality and dimensions. In the Wiconisco Basin, and also in the Dauphin Coal-field, the conglomerate embraces, as we have already seen, one or two beds of coal of a profitable size and of good quality ; but in the district before us, this stratum includes as many as five separate seams of the best free-burning anthracite, four of them of large dimensions, and of unusual excellence in the quality of their fuel. It would appear to be a general fact in the relative distribu-

tion of the coal within the strata, that the lower stratum (the conglomerate) becomes a productive coal-bearing member of the formation only when we approach the W. terminations of the two great S. basins, and this not in an equal degree as regards these basins, but in a ratio of much more rapid increase in the more Northern of the two, the great Shamokin Valley. The direction of maximum development of the lower coals has therefore been nearly due Westward, or into the W. end of the Shamokin Basin, from the region of the Schuylkill, and not strictly along the course of the Southern or Pottsville Basin.

Owing to this unusual expansion of the coal-seams of the lower division of the formation in the W. part of the Shamokin Basin, the quantity of coal is greater for the thickness of the strata embracing it, than in any other quarter of the anthracite region. The actual depth, or thickness of the whole formation, including its inferior member—the conglomerate—at Zerbe's Gap, does not exceed 1000 feet. This mass of strata consists of two nearly equal divisions: the lower, comprising a little more than 500 feet, consists of five separate beds of massive silicious conglomerate and coarse sandstone, alternating with five deposits of argillaceous shale and slate, the conglomerate constituting about one-half of the whole thickness. Each of the argillaceous or slaty deposits contains a thick bed of coal. The upper division consists mainly of bluish shales and dark carbonaceous laminated coal-slates, and includes five separate and recognisable beds of fine-grained compact silicious sandstone, one of which, the fourth in ascending series, is surmounted by a thin pebbly rock or conglomerate, easily distinguishable from the conglomerates of the lower series by the smaller size of its fragments. In this upper series there occur on Zerbe's Run eight separate beds of pure coal, five of which, and occasionally a sixth, are amply large enough for profitable mining, three of them being of rather extraordinary size. Thus in the whole thickness of about 1000 feet of coal-rocks, thirteen beds of coal present themselves, nine of which are everywhere large enough and pure enough to be advantageously wrought.

DESCRIPTION OF THE INDIVIDUAL COAL-SEAMS IN THE ASCENDING ORDER.

Coal Zero.—The lowest coal, called *Zero*, from its underlying the No. 1 of a previously-established enumeration, occurs within a short distance of the upper limit of the Umbral Red Shale; its total thickness is about $5\frac{1}{2}$ feet, but it contains near the middle a layer of slate 18 inches thick, which divides it into two benches of coal, an upper one $2\frac{1}{2}$ feet, and a lower one $1\frac{1}{2}$ feet thick. It has been proved and drifted on, but not hitherto mined in a permanent manner. It is illustrated by the accompanying cut.

Fig. 245. — Lowest Coal, Zerbe's Gap.

Coal I.—This, the second bed of the conglomerate series, lies within 100 feet of the base of the formation. It passes under the entire basin, and has its N. outcrop usually on the first bench or platform outside, or N. of the crest of the North Mountain, and its S. outcrop generally on the second bench, outside or S. of the summit of the South Mountain. It has been already mined to some extent in the end of the North Mountain, at the gap, and there displays a thickness of $12\frac{1}{2}$ feet of excellent free-burning and flaming anthracite. Of the $12\frac{1}{2}$ feet of coal, about 11 feet are of superior quality, adapted to the market. Further E., about half a mile, this coal shows a thickness of 8 feet in a superficial shaft on the mountain. On the S. side of the basin it has a thickness, where it has been opened, of 11 feet. We may safely

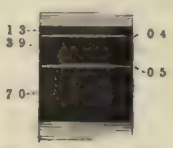


Fig. 246.— Coal I., Zerbe's Gap, Trevorton.

estimate it to possess 9 feet of available coal, or to contain *three tons* to each square yard of surface.

Coal II.—This coal overlies the second layer of conglomerate, and is higher in the series than Coal I. by about 150 feet of strata. Its outcrop is usually indicated by a distinct bench on each mountain, and its horizontal distance from the outcrop of Coal I. is, on an average, about 250 feet. The line of its outcrop along the Northern Mountain is immediately to the S. of the highest crest, which is here formed by its underlying conglomerate. On the South-bounding ridge it comes to the day sometimes on the first bench, sometimes on the second S. of the main crest of the mountain. The average thickness of this coal would appear to be about 8 feet, and we are safe in computing the quantity of good fuel in it at 6 feet, or 2 tons per square yard of surface.

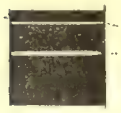


Fig. 247.—Coal II., W. side of Zerbe's Gap.

Coal III.—Separated from Coal II. by about 120 feet of strata, and distant from it usually about 200 feet, at a dip of 45°, Coal III. is easily traced along the next parallel interior bench or terrace. On the S. barrier of the basin this bench is conspicuously marked, and throughout the greater part of its course from W. to E., it lies immediately N. of the crest outcrop of conglomerate, except next the E. end, where it changes to the S. or outside base of the crest ledge. Conglomerate No. 3, which underlies it, and also conglomerate No. 4, above it, are thinner and less massive rocks than conglomerate No. 2, and therefore the terraces defining Coals III. and IV. are, for the most part, more obscure than those of either Coals II. or I. Along the S. side of the crest of the N. barrier, the want of prominence in the third and fourth conglomerates causes the outcrops of Coals III. and IV. to be only very vaguely indicated on the surface. A knowledge of their distances from the other better-defined outcrops is here, therefore, very important.

West of Zerbe's Gap, Coal III. has, on the North Mountain, an average thickness of about 10 feet; and E. of the gap, on the same line of outcrops, the shafting shows it to contain about 8 feet of coal, of which 7 feet are of excellent quality. Making a fair abatement for accidents and inevitable waste, this coal will yield, I think, at least 6 feet of marketable fuel.

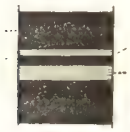


Fig. 248.—Coal III., near Zerbe's Gap, Trevorton.

Coal IV.—Divided from Coal III. by the thin conglomerate No. 4, this coal occupies for the most part the same broad bench with it; they are separated by about 70 or 80 feet of strata, and on the N. side of the basin are in some places yet nearer together. The horizontal space between their outcrops, therefore, rarely exceeds 100 feet. Coal IV. is generally rather thinner than either of the other three conglomerate coals. We shall be very safe, however, in assigning to it a productive thickness of 6 feet.

Coal V.—This valuable and large bed, the lowest of the sandstone series, has its outcrop invariably at the base of a long slope formed by the upper or fifth belt of conglomerate, on a terrace or bench somewhat lower on the inner flank of the mountain than those above described. It overlies the conglomerate from 20 to 25 feet, the interposed rock being a soft blue argillaceous shale. Above it is a thickness generally of 60 feet of similar shale and dark carbonaceous slate. The edge or brow of the terrace, along which this coal appears, is formed by a fine-grained compact flaggy sandstone, usually from 16 to 20 feet in thickness; the terrace, thus supported, exceeding 100 feet in width.

This coal-bed has an average thickness in this district of about 15 feet, but in some places its outcrop shows it to contain even 17 feet of good coal. It is exceedingly pure in quality. Underlying the entire basin, between its N. and S. outcrops, which are high on the flanks of the bounding mountains, it constitutes of itself, from its great thickness, a coal-field of enormous capacity. It will be perfectly prudent to estimate it as yielding a thickness of 10 feet of coal fit for market, and as holding in the North Mountain, where it is at present most accessible, a breast above water-level of at least 500 feet.

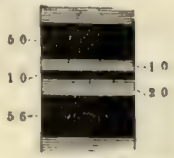


FIG. 249.—Coal V., Zerbe's Gap, Trevorton.

Coal VI. is a thin coal, pure in quality, but seldom met with of a greater thickness than 18 inches, and therefore not at present of any commercial value. It lies about 20 feet above the first sandstone.

Coal VII.—This is a coal which varies in size from 5 to 7 feet. Its available dimensions may be estimated at 4½ feet, and its capacity, therefore, at one and a half tons to the square yard of surface. I shall assign to it, however, 1 ton. It has its extreme outcrops high on the sides of the coal valley, usually about 100 feet from the outcrops of Coal V., on the gentle slope below the terrace connected with that coal. This is the lowest coal-bed of the whole series which reaches the day in the anticlinal tract of the middle of the basin. It is high enough to be brought to the surface over the centre of the arch or saddle, where the first tributary of the Eastern Branch of Zerbe's Run passes through the central ridge by a somewhat deep transverse valley or ravine. At this point the coal has been opened precisely at the saddle or anticlinal axis, at an elevation of about 50 feet above the bed of the ravine. If at some future time it were deemed desirable to extract the coal from this bed in this central belt, the spot here designated is a very favourable one for the construction of slope-workings, by which it might be wrought on both the N. and S. dips of the saddle.

A perpendicular shaft in the valley of Zerbe's Run, at the foot of the North Mountain, only a few hundred feet in depth, would, by penetrating to the bottom of the N. synclinal trough embraced between the mountain and the middle ridge, gain ready access not merely to all the coal of this bed under the water-level, but to that far larger amount which the basin there contains in the five great underlying seams previously described.

Coal VIII.—Immediately upon Coal VII. is the second sandstone, usually about 15 feet thick. It forms, in most localities, the margin of the sloping bench which holds the outcrop of Coal VII., and gives rise to a slope of the surface, about midway upon the flank of which we are entitled to look for the outcrop of the large and excellent Coal VIII. This coal-seam, which is remarkable throughout the district for its superiority, and the great persistency of its features, is a double or twin bed, being divided in the centre by a layer of soft argillaceous shale, often a pure fireclay, which, though seldom a foot in thickness, holds its place and size, with little variation, over an extent of some miles. The position of the Northern and Southern outcrops of this coal is about midway on the long gentle ascent of each mountain which leads up to the terrace of Coal V., at the foot of the first steep acclivity, or that of the upper conglomerate. Its average angle of dip on the two sides of the basin is about 45° or 50°. Passing under the two lateral basins, it rises in the anticlinal arch of the central broad ridge, and has here been opened immediately on the top of the saddle W. of a transverse ravine, a mile E. of Zerbe's Gap. Farther W. it is overarched by higher strata, but throughout the whole length of the district of the East Branch of Zerbe's

Run, this coal is elevated nearly to the surface, along the centre of the anticlinal belt, and presents, especially in the N. side of the ridge, a valuable and tall breast of coal with a moderately gentle N. dip.

This bed has an average thickness of good coal of at least 14 or 15 feet. On the North Mountain it displays, in a well-opened shaft, a total thickness of 22 feet. We are within bounds, therefore, in assigning to it, after deduction, a product of 4 tons per square yard. In the North Mountain E. of the gap, its breast above the water-level is not less than 600 feet, in consequence of a flattening of the dip due to an anticlinal fold which lies near its outcrop on the slope of the ridge.

Coal IX.—This is generally the thickest coal-bed of the series. When in fullest development, as in the vicinity of Rennie's Cottage, it consists of two separate layers, the higher being from 15 to 16 feet thick, and the lower about 4 feet. In many localities, both E. and W. of the Gap, the lower bench is either absent or very thin. The coal, a soft free-burning and flaming anthracite, is, for so large a bed, singularly pure, being free from both sulphur and slate. At a very moderate estimate, this coal will yield 4 tons to each square yard of surface. In the North Mountain, its line of outcrop is low on the flank of the ridge, and the breast of coal there, above water-level, does not probably exceed 200 feet. In the central anticlinal ridge, where its outcrop follows the N. brow of the hill for the whole length of the stream, at an average vertical height of 200 feet, and a dip which rarely exceeds 30°, the extent of the breast is at least twice as great.

Between Coal VIII. and this Coal IX. there is a coarse grey sandstone, No. 3, the outcrop of which frequently forms, for the two coal-beds, two independent benches, or else two separate slopes. Overlying Coal IX. is a coarse, gritty, whitish sandstone, No. 4, divided from it by about 110 feet of soft slate.

Coal X.—Above the large bed, Coal IX., at an interval of about 30 feet, is the thin Coal No. X. It is of no economical importance, since it rarely contains 2 feet of good coal. The roof or top slate of this seam is unusually rich in the flattened stems of several species of *Sigillaria*, one of the chief coal-producing plants. They are thoroughly compressed, and form a complete matting. At one spot near the gap, the strata having a perpendicular dip, this top slate is exposed to the open day at a superficial trench excavated in the outcrop of the coal-bed. (See the Sketch at the end of this Chapter.)

Coal XI. overlies Coal IX. at an interval of from 90 to 100 feet. This coal is occasionally 3 feet thick, and is then of available size, and may be estimated at 1 ton of good coal for each square yard of surface; but it cannot at present be included in any account of the resources of the coal district.

Coal XII.—The sandstone, No. 4, is surmounted by a fine-grained conglomerate, which everywhere along the summit of the central ridge exposes two well-marked lines of outcrop, serving as excellent external guides to the position of the adjacent coals. Overlying this conglomerate is a thin body of slate, and then a thin sandstone, and at a short interval above this sandstone lies the upper coal of the whole series, Coal XII. of our enumeration. This bed is generally double, its lower layer being about 5 feet thick, separated from the upper, which is from 1 to 2 feet thick, by 2 feet of sandstone and slate. It may be safely estimated to afford 1 ton of good coal to each square yard of surface. Its outcrop on the North Mountain is too low above the water-level to make it eligible to mine it there at this time, but in the N. flank of the

central ridge it has a breast of considerable height, probably not less, on an average, than 100 yards.

If at any time it were thought desirable to enlarge the productive capacity of the district by an additional series of collieries, the whole central belt of the basin, and its entire S. side, may be promptly and effectually laid open to the same low water-level by the construction of a single transverse *tunnel*, entering the central anticlinal ridge opposite the gap, and penetrating Southward to the lowest coal-beds of the S. barrier. This tunnel would, near its mouth, procure access to tall breasts of coal on the several large North-dipping beds of the anticlinal ridge; further in, it would intersect the same coal dipping Southward, and further still, it would cut deep across the broad basin at the foot of the South Mountain, and terminate beyond in the coals of the conglomerate series, at so low a relative level as to lay open working breasts of the entire sloping height of the ridge. By this tunnel, which would be equally available for the development of the central and Southern tracts of both the E. and W. divisions of the district, all the coal anywhere above water-level, even to the Eastern boundary of the valley of Zerbe's Run, would be procurable without machinery. As the tunnel would expose new and extensive breasts of thick coal at short intervals of its progress, its cost would be covered as it proceeded. If judiciously planned, such a work might, I feel confident, give outlet to at least 12,000,000 of tons of coal.

The researches undertaken permit us to calculate, with very considerable precision, the grand total of coal embraced within the limits of this coal-field. By the estimates already presented, the aggregate thickness of the coal truly available in the beds appears to be about 70 feet. But it is not of this full thickness under every part of the valley, since the higher seams—and among these occur the largest ones—do not spread across the basin to limits as wide as the lowest.

In all my estimates of the amount of available coal in each bed, compared with the total quantity contained between the roof and floor, I have been studious to exceed rather than to underrate the proportion of waste arising from the operations of mining, and from the more or less squeezed or crushed condition incident to the coal in all basins where the bounding dips of the strata are at all steep. Much attention has been devoted to the detection of the probable amount of this last-mentioned element of waste. In the Shamokin, and in every other anthracite coal-field, portions of certain coal-beds are necessarily faulty, and as usual the most disturbed part of the basin is its S. margin. Even there, however, the proportion of the crushed coal to the undisturbed, owing to the regularity of the dip, is less than belongs generally to the North-dipping belts of strata of the more Southern coal-fields. Throughout the N. side, and all the central tracts of the estate, the prevailing soundness of the coal is remarkable.

It is a highly favourable circumstance in the structure of this whole Western division of the Shamokin Basin, that its natural outlets, and therefore its deepest water-levels, and first available breasts of coal, are all on the *N. side*, and not, as in nearly every part of the Pottsville Basin and its branches, in the Southern Mountain barrier. By this condition of things, the most accessible part of the coal-field is at the same time the soundest, and all those great breasts of coal, which will call for the least preliminary outlay for development, are precisely those also which will call for least expense in mining, and involve to the collier the smallest delay and disappointment. Those persons who are at all familiar with the history of the mining enterprises of the Southern anthracite basin, will justly appreciate the value of this fortunate combination of low water-levels with a great range of regular South-dipping strata.

It is obvious, from the foregoing statements respecting the thicknesses of the several coals, and their high breasts above the existing water-levels, that the present productive capacity of this coal-field is unusually great. Its facilities for furnishing a large annual supply of good coal to the market, at a minimum of preliminary arrangements for mining, are indeed remarkable. Extensive collieries, working above the water-level, are already organised, from which, without any expensive erections, a large amount of coal can be annually sent to market over the Trevorton Railroad, now constructed to the Susquehanna.

In no part of the anthracite coal-region do all the conditions favourable to facility and cheapness of mining concur to a greater extent than in this basin.

Having now offered a general sketch of the structure and large resources of the coal-field of Trevorton or Zerbe's Gap, I shall submit a brief description of the coal itself.

Obeying the general law of gradation exhibited in the composition of the coal in all the great anthracite basins of Pennsylvania, that of the Shamokin Valley grows progressively softer and less compact, and more gaseous and free-burning, as we follow it toward its Western termination. Passing the meridian of the Shamokin Gap, the coal acquires a sensible quantity of the inflammable gas (carburetted hydrogen) characteristic of the bituminous and semi-bituminous class of coals, and the proportion of this ingredient seems rapidly to increase as we draw near to the extremity of the basin: it is therefore at its maximum in the terminating coal-field before us. It constitutes probably not more than eight or nine per cent by weight of the coal at Zerbe's Gap; yet small as is this amount of the volatile matter, it imparts to the fuel properties which, for an anthracite, are peculiar, and some of which are highly valuable. It seems to exist in the coal in the gaseous form, or if a portion of it is in a condition of liquid bitumen, it is in quantity too minute to cause the coal to soften and form coke. The coal is therefore to be regarded as an anthracite, but of modified properties. When a portion of the coal is freshly thrown upon an ignited fire, it begins very quickly to discharge its inflammable gas, which may be seen burning with its peculiar yellow flame, and causing by its ready combustibility the solid part of the coal itself to pass rapidly into full ignition. It is otherwise with the hard varieties of anthracite; these are destitute of any such *good kindling*, and are, moreover, slow to burn from their extreme compactness, so that when they are cast fresh and cold upon a fire, they check seriously the vigour of the combustion, and produce irregularity in the heat. The quality of being easily kindled confers on these free-burning semi-anthracites an especial fitness for generating steam. From the same property will arise an important economy in the consumption of the coal, as this can be kept ignited in small quantities, and in a state of low combustion; while the harder and less ignitable kinds, not burning at all but at a higher temperature, will either go out altogether, or produce a fire which, for many purposes, is wastefully active and intense.

Some of these free-burning coals of this Western Shamokin coal-field are liable to crumble or fall, to a certain degree, during the first stages of their combustion; though it is to be observed, that the coal hitherto submitted to experiment has been procured from near the outcrops of the beds, or where the mine has but little cover. Analogy tells us that the coal will be firmer on the fire when taken from a deeper source. I think, however, that this tendency to crumble when burning is partly inherent in the composition of the coal, and is in fact connected with the disengagement of the inflammable expansible gas before referred to, which, in assuming the volatile condition, swells and severs the coal by its minute mechanical fissures. The breaking up of the

coarse lumps into smaller ones, while it greatly increases the total surface exposed to combustion, does not necessarily lessen the aggregate quantity of interstitial space for the passage of the air. There is just the same proportion of air-space in a cubic yard of *small shot* as in a cubic yard of cannon-balls. It is a fixed geometrical ratio. It must be acknowledged, however, that the soft coals demand additional force of blast.

The openness of the fire to the air is furthermore preserved by a valuable quality in the earthy residuum of these coals. The ash is white and apparently very silicious, and therefore extremely infusible. The flakes cohere only by their corners and edges, and form a loosely porous, open, spongy mass, entirely pervious to the draught. The residuum does not readily melt into a tough dark slag, such as some coals produce, which chokes the grate of the furnace, clogs the interstices of the fuel, and interferes seriously with the combustion, permitting at the same time the bars of the grate to go rapidly to destruction.

In point of purity, or freedom from earthy matter, these coals of the W. end of the Mahanoy and Shamokin Coal-field will take rank with the very purest to be met with in the anthracite country. This is confirmed by chemical analysis. The lowest bed of all, and the two upper large ones of the sandstone series, are remarkable for the small proportion of ashes which they yield. The entire freedom of all the coals from sulphur is an attribute not less distinctive, and is an important recommendation to their employment in the smelting of iron, and in the furnaces of steam-engines. The hydrogen of the gaseous part of the coal is a potent purifier, or remover of any sulphur with which either the iron ore or the coal itself might be contaminated. The excellence of the iron of the bituminous blackband ore of Scotland is admitted to be due to the purifying influence of the hydrogen of its bitumen.

FIG. 250.—View of the Top Slate of Coal No. X., near Zerbe's Gap, Trevorton, showing matted flattened stems of Sigillaria.

DIVISION IV.

NORTHERN ANTHRACITE COAL-FIELD, OR BASIN OF THE LACKAWANNA AND NORTH BRANCH OF THE SUSQUEHANNA.

CHAPTER I.

TOPOGRAPHICAL FEATURES, COMPOSITION OF THE STRATA, AND GENERAL STRUCTURE OF THE BASIN.

FORM AND INTERIOR FEATURES OF THE VALLEY.

LIKE the other anthracitic coal-fields of Pennsylvania, this large and rich basin of the Lackawanna and North Branch of the Susquehanna is surrounded by a double belt of mountain-summits ; but instead of that usually entire separation of the inner and the outer ridges which is so conspicuous in the Pottsville, the Shamokin, and other coal valleys, the intervening deep narrow valley of Umbral Red Shale is here only a high sloping platform or bench on the side of the exterior mountain, and the interior crest is but a subordinate ridge or shoulder between this bench and the main valley. This feature in the encircling high lands, of a coalescing of the two parallel ridges into one mountain mass, grows more and more obvious as we advance N.E. along the Wyoming and Lackawanna Basin, increasing as the soft shale-formation, which produces the valley between the ridges, lessens in thickness, and as the dip of the strata, another influential condition, becomes progressively flatter. Towards the W. end of the basin, where the easily excavated Red Shale, and the soft sandstones belonging to it, hold a thickness of several hundred feet, and where, moreover, the inclination of the strata is as steep as from 30° to 45°, we may discern from any high points, like those overlooking Solomon's Gap, the distinct division of the enclosing mountain into its two crests ; but from Wilkesbarre N.E., and especially between Pittston and Carbondale, where the shales thin down, and at last almost disappear, and the dip declines to no more than 10° or 12°, this separation grows to be very dimly defined, except just where—as in the upper valley of Stafford Meadow Brook and its prolongations—the waters which have ploughed the surface have been assisted in cutting a deeper longitudinal trough than ordinary, by the extra strength and keenness of current imparted to them through the existence of transverse notches promoting their rapid outflow.

The coal-field, or trough of the coal-containing strata, encompassed by this picturesque mountain-rim, is a very elongated valley, some 50 miles in length, from Beech Grove to Carbondale, and not more than 5 miles wide in its broadest central portion, between Solomon's Gap and the entrance of the Susquehanna at Pittston. Its form is that of a very regular symmetrical crescent, curving in its course as much as 50°—the N. horn at Carbondale pointing about N. 20°

E., while the W. one at Beech Grove is directed only 20° S. of W. In its interior features this valley is extremely diversified, and is full of landscapes of uncommon beauty. From Pittston to Nanticoke, or between the points where the Susquehanna enters and leaves the basin, the N. half of the main bed of the valley is a wide level fertile plain, or low diluvial floor, watered by the tree-fringed river. A similar but narrower belt of low ground, underlaid in like manner by a deep deposit of drift or gravel, winds through the whole length of the upper N.E. portion of the valley, or that occupied by the Lackawanna. Everywhere else between these river-plains and the flanks of the bounding mountains, and throughout the W. end of the basin, its surface is undulated with a multitude of approximately parallel chains of hills and denuded ridges, which, in nearly all the district between Beech Grove and Wilkesbarre, are sharp-crested, steep, and much ravined and cut, but show wider summits, and softer slopes and outlines, progressively, as we follow them towards the Lackawanna and ascend its valley. This change of feature is very striking when we contrast the long, steep-sided, narrow-backed ridges between the S.W. end of the valley and Solomon's Gap, with the wide, flat-topped, or gently-sloping plateaus between the falls of the Lackawanna and Carbondale.

GENERAL VIEW OF THE STRATA.

Taking a comprehensive survey of the several rocky strata which surround and are embraced within the Wyoming and Lackawanna Basin, they will be found to constitute four distinct groups, differing in their positions and composition, and in the value of their imbedded deposits. As the Sections will show, they are inconstant in type and thickness.

1. The first and lowest in the order of stratification is a thick series of grey sandstones, occasionally pebbly, and including beds of shale. This outcrops high on the inner slope and summit of the outer broad mountain-ridge of each border of the basin. The formation is several hundred feet thick, but is variable in size and type, as the columnar Sections here given will show. It is the lowest or oldest of our American carboniferous strata, but in this part of the mountain-chain of the country it contains no coal, nor any notable amount of iron ore. It is our Vespertine series.

2. Next in succession, overlying this formation, and outcropping usually in a high bench, but sometimes in a valley, following the inner slope of the outer or main mountain all round the coal-basin, occurs a mixed group of strata, red shales in the inferior portion, grey sandstones and buff-coloured slates in the middle, and a peculiar hone-like very close-grained calcareous sandstone in the upper. Such is the character of this Umbral formation in the vicinity of Scranton, and elsewhere on the borders of the Lackawanna division of the basin, where its total average thickness does not amount to 350 feet, and where the Red Shale of the lower member of the mass is extremely thin, and in places altogether absent. But further S.W., especially between Solomon's Gap and Beech Grove, the Red Shale assumes great relative bulk, and the middle and upper divisions, as at Nanticoke, are comparatively much reduced, the whole formation being from two to three times as thick as where it

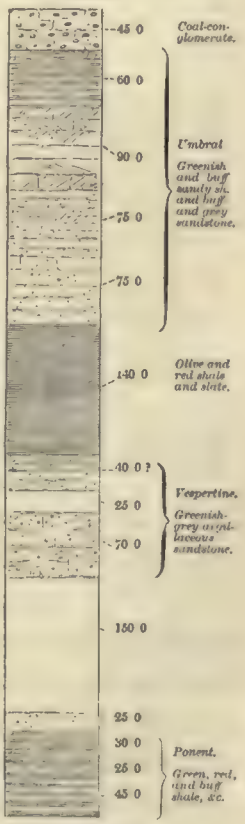


Fig. 251.—Cobb's Gap, of Roaring Brook.—1 *inch* = 200 *feet*.

bounds the Lackawanna Valley. It is among the layers of the lower or shale group of this formation that we encounter the interesting *calcareous iron-ore* of the Stafford Meadow Valley, once extensively mined on the Lackawanna Iron and Coal Company's lands, and smelted in the furnaces at Scranton. The whole formation is the Umbral series, or middle carboniferous formation. To the easily-worn nature of its shaly beds, contrasted with the far superior resisting powers of the Vespertine sandstones beneath them, and of the equally hard middle and upper members of their own formation, supported by the still more massive and cohering conglomerates of the base of the Coal-measures just overlying these, we must attribute the prevalence of the mountain valley or broad bench on the mountain-side, already described as so general a feature along the outer edge of the coal-field. The cuts here presented display its variability of composition.

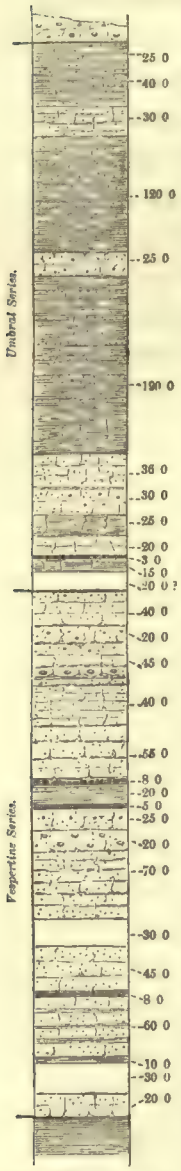


FIG. 252.—Vespertine and Umbral Strata at Solomon's Gap.—1 *inch* = 200 *feet*.

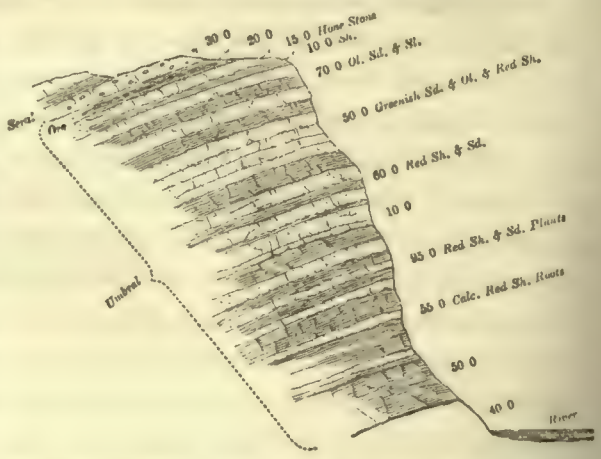


FIG. 253.—Umbral Red Shale, Nanticoke Mountain, at Nanticoke.—1 *inch* = 200 *feet*.

3. Immediately over the fine-grained, hone-like sandstone of the top of the Umbral series rests the Seral conglomerate of our classification, a coarse massive white-and-grey conglomerate, constituting the base or supporting member of the productive Coal-measures, or upper carboniferous series. All round the Wyoming and Lackawanna coal-field, this well-known and easily-recognised rock is composed of two sets of strata: a lower group, made up in large part of extremely coarse pebbles of nut size, of white quartz and grey sandstone, compactly cemented into thick and ponderous beds; and an upper group, of less massive layers of a smaller-grained conglomerate and dark-grey sandstone, the pebbles seldom exceeding the size of a pea or small hazel-nut. The average thickness of the lower mass on the S.E. side of the basin is from 70 to 80 feet, whereas on the N.W. side it seems nowhere to exceed 40 feet; that of the upper fine-grained rock varies from 60 to 90 feet, but shows no such marked reduction in passing from its S.E. to its N.W. outcrop. At Scranton, on Roaring Brook, the coarser rock is about 80 feet thick, and the finer grained, which is here quarried, and makes a valuable strong building-stone, is about the same thickness. In some parts of the anthracite coal region, and possibly in certain localities on the borders of the Wyoming Basin, indications exist of the presence of a bed of coal in the shales which sometimes separate these two divisions of the conglomerate. This fact, and the identity in composition of the upper member with the coarser grits of the true Coal-measures, induces me to class it as a part of these, though, as it usually lies below any workable coal, it may equally retain its place as a division of the conglomerate upon which it directly reposes, and into which it in many places graduates. In fact, a comprehensive study of the lower coal strata, and of the conglomerates interstratified among them, distinctly shows

that even the main undermost coarsest pudding-stone, or Seral conglomerate, is itself properly but a member of the true Coal-measures, and in no sense an independent formation. There are, as we have already seen, several districts in Pennsylvania where productive coal-seams occur imbedded within this coarsest lowest mass, and others indeed where such exist even beneath or outside of it.

It has been the superior firmness of cohesion or solidity of this rock, compared with that of the softer overlying Coal-measures and underlying Umbral group, both abounding in slates and shales, that has enabled it better to resist the tremendous furrowing action of the waters which carved the land into its present inequalities, and caused it to stand out above the deeper-ploughed surfaces of those formations. Wherever a notch or breach through the conglomerate and a considerable steepness of dip have promoted a deeper than usual grooving of the Umbral shales behind it, this coarse rock rises forth in a more or less ragged and naked crest, forming the inner of the two mountain-summits already mentioned as bounding the coal-basin; but where the denudation has been more uniform down the mountain-side, and the inclination of the strata is gentle, it forms rather the front or supporting edge of a horizontal or sloping shelf than a separate ridge. The edge of this mountain shelf or ridge, as the case may be, is the readily distinguishable boundary of the productive Coal-measures, the lowest notable coal-bed usually outcropping on the valley-side some distance below the slanting ledge of naked coarse pebble rock. Where the dip is extremely flat, however, and the conglomerate uncommonly thin, the last coal-seam will often have its margin or outcrop almost as high on the mountain-side as the pudding-stone, but it then outcrops at a still wider interval inside of that rock. This latter state of things prevails in the vicinity of Scranton on Roaring Brook, and elsewhere on the S. side of the coal-basin. The average dip of the strata N.W. does not there exceed from 3° to 5°; and as about 100 feet of lower Coal-measures, embracing two or three thin coals, intervene between the top layers of the upper conglomerate and the lowest seam worked, the horizontal space between the pebbly rock and this coal-bed is often 800 and sometimes 1000 feet. To determine, therefore, the true limits of the available coal-lands of a district by the position of the exposed outcrop of the conglomerate, in default of sufficient openings in the coal itself, demands a nice attention to the several circumstances of the rate of dip, the thickness of the interposed strata, and the features of the denudation, or of the washing away of the overlying coal-containing rocks from off the barren floor of conglomerate.

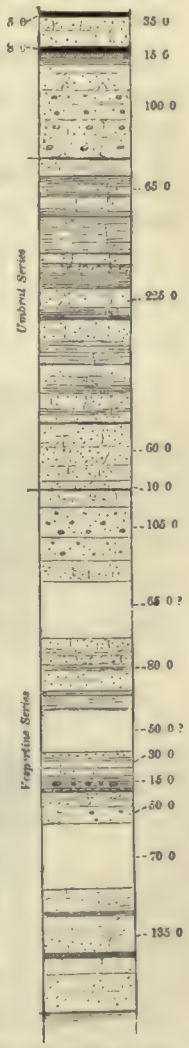


FIG. 254. — Vespertine and Umbral Strata, Hertzoff Hollow, N. of Kingston.—1 *inch* = 200 *feet*.

4. The last and highest of the formations of the region in the order of stratification is the Coal-Formation proper. In the Wyoming and Lackawanna Basin, this consists, as is well known, of coarse and fine-grained grey micaceous sandstones, pebbly in some of their beds; and of argillaceous sandstones, shales, slates, and fireclays—some more silicious and gritty, some more aluminous and smooth;—and between all these are interstratified beds of anthracite of all dimensions, from a few inches to many yards in thickness. All the coal-seams, with one or two very local

exceptions, yield either white or grey ashes; and as in the Pottsville and Shamokin basins the coals of this character are overlaid by a group of beds, producing red and brownish ashes, such as are not here met with, it is fair to infer that in this Wyoming Valley we have the representatives of only the White-Ash and Grey-Ash groups of the other great basins. Denuding action, which has been especially powerful here, may have swept off the once overlying and more exposed Red-Ash series, or these possibly may never have been formed in this Northern district.

It is impossible to estimate with precision the total thickness of the Coal-measures in the deepest parts of the Wyoming and Lackawanna Basin, or to count with accuracy the number of the available beds of coal in those localities; but exact measurement discloses in the vicinity of Wilkesbarre—the widest and apparently the deepest portion of the coal-field—the existence of from 1000 to 1200 feet of coal-bearing strata, and the presence within these of *sixteen* or *eighteen* separate beds of coal; two or three of these being compound seams of great size, and some ten or more of the whole series being permanently of ample dimensions for profitable mining. This depth of the Coal-measures, and number of the contained coal-seams, grows less, of course, from the centre of the basin towards its two margins, and also towards its two contracting extremities.

As a provisional classification convenient for present reference, the whole body of the Coal-measures, or coal-containing strata of the basin, may be divided into two groups—*first*, a *lower series*, comprehending all the coals, some nine or ten in number, great and small, from the Seral conglomerate to the highest of the set embracing the great Wilkesbarre or Baltimore Company's seam; and *secondly*, an *upper group*, of about seven or eight beds in all, commencing with the large Pittston or Fourteen-feet bed as a base, and terminating with the Four-feet Coal of the immediate vicinity of Wilkesbarre, the uppermost whose position I have yet positively determined anywhere in the coal-field. It is proper to observe, that while the lower group contains, where it is fullest and best exposed, some ten independent coals, there are usually not more than five of these of such dimensions and purity as to fit them for profitable mining; while from the great fluctuations in both of these conditions to which this series of coals is liable beyond all other divisions of the whole coal-formation, there are districts where no more than two or three of the beds are large enough and good enough to prove of any commercial value. In like manner, while the upper group includes of large and trivial beds as many as seven or eight, there is no neighbourhood where more than four of these are of suitable size and quality for working, and in some localities the number of such is even fewer.

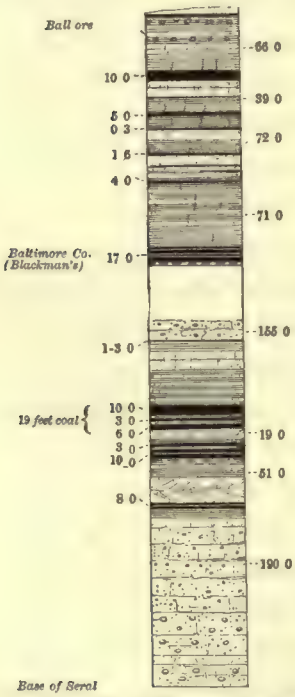


FIG. 255.—Wilkesbarre Lower Coal-measures near Solomon's.—1 *inch* = 200 *feet*.

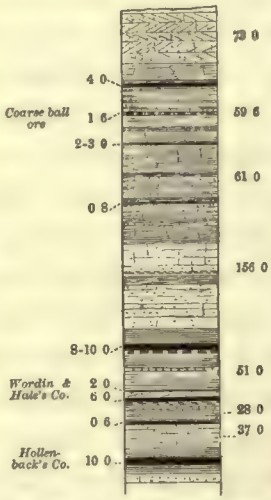


FIG. 256.—Wilkesbarre Upper Coal-measures (mouth of Mill Creek).—1 *inch* = 200 *feet*.

As regards the limits and distribution of these two divisions of the Coal-measures within the basin, it suffices, for our present purpose of a general comprehensive survey, to recognise the fact, that the upper group is restricted to a comparatively short and narrow elliptical belt in the very central tracts of the coal-field, its S. margin passing through the low grounds S. and S.E. and E. of Wilkesbarre, and by the valley of Laurel Run and White Oak Hollow to the S. of Pittston, and the whole of this basin of the upper measures terminating some 2 miles to the N.E. of the mouth of the Lackawanna River (see its boundary on the Map). On the other hand, the lower series occupies the entire area of the coal-field underlying the small central basin of the upper group, and emerges to the surface all round it, one broad outcrop filling the whole S.E. side of the valley from the margin indicated, to the S.E. conglomerate barrier, and another, the N.W., to the same terminating rock on the opposite mountain. Below Nanticoke and above the vicinity of Pittston, or throughout the Lackawanna Basin, these same great lower coals fill the whole breadth of the valley from mountain to mountain, unconcealed by any overlapping beds of the upper set.

GENERAL STRUCTURE OF THE BASIN.

In order to convey a correct conception of the conditions under which the coal-beds and coal-rocks of this valley lie, and their accessibility for mining, it is expedient to refrain a little longer from local descriptive details, and proceed to a few preliminary considerations respecting the general geological structure of the whole coal-field. We shall be thus prepared to understand much more precisely the peculiar distribution of the coal.

In its general configuration the Wyoming Basin is a wide and shallow trough, somewhat deeper in the middle than at the sides, yet descending so gradually as to be, if we disregard the subordinate undulations of the strata, approximately flat towards the centre. This prevailing levelness of its bed or floor, notwithstanding the considerable angles of dip—at the margins frequently more than 30°—is at once apparent when we compare the great width of the valley, 4 or 5 miles in its middle district, with the very moderate depth of 1200, or 1500, or perhaps 1800 feet, which the sections seem to assign to it, in this its most capacious portion. Laborious explorations and measurements have enabled me to bring to light within the general basin the existence of a great number of nearly parallel lesser troughs or basins, with intervening saddles or anticlinal waves in the coal strata, and to trace these individually, and develop the law of their direction, and their effects on the local distribution of the beds of coal. These investigations have shown that the same coal-seams and other strata are repeated, within certain limits, from one wave to another, so as to maintain, despite the local steepnesses of dip, one average uniformity in the depth of the coal-field at any given cross-section. This general levelness of the bottom is independently established by a comparison of the vertical thickness of the strata at many points within the valley.

The whole coal-valley may be likened to a flat-bottomed boat, tapering gradually from the middle towards both extremities, and as gradually shoaling up in those directions ; though the boat is not a straight one, but curves constantly, crescent-like, towards one side, and the resemblance is further deficient in the bottom not being smooth, but ridged with the waves above spoken of. This shoaling or thinning, by superficial removal, of the Coal-measures, towards either end of the trough, though within restricted limits locally modified by the undulations, is not a

uniformly progressive feature, but advances suddenly, and then more slowly, along certain portions of the valley. Thus it seems to proceed rather rapidly from Wilkesbarre N.E. past Pittston, and to be almost arrested, thence along the Lackawanna Valley from near the mouth of Spring Brook, until we pass beyond Scranton, while a more rapid lifting-out of the strata seems again to commence near Legget's Gap, and to continue steadily to the termination of the basin at Carbondale. This fact of the very slow rise of the coal-rocks as we ascend the Lackawanna from the Falls to a mile or more beyond Scranton, would seem, at first glance, to nearly equalise the quantity of available coal for equal areas throughout this reach of the valley; but a detailed examination of the comparative resources of the several tracts of this district discloses quite remarkable differences, dependent on various conditions not connected merely with the depth of the Coal-measures. Among these modifying circumstances, those of conspicuous importance are, the variations in the number, thickness, and purity of the coal-beds within the same mass, or thickness of coal strata; the comparative quantities of minable coal above the beds of the ravines and valleys, the accessibleness of the coal to economic mining and ready drainage, as affected by the direction and degree of dip of the strata, and the greater or less extent to which the strata, and especially the seams of coal, are obscured, preventing successful mining, or concealed altogether from discovery by the very unequal covering of drift or gravel which hides from view large patches of the coal-formation in this part of the basin. So influential are these and other conditions on the productive capacity of any given tract, that it may be said that a different mining value characterises every different half square mile of the valley, rendering it quite unsafe to infer from the ascertained geology and resources of one range of land, the commercial value of grounds adjoining, unless these have been themselves carefully and experimentally opened, and the specific relations of the unknown portions to the known, well established. Circumstances seemingly the most trivial—as, whether with a gentle dip the coal-beds lying above the water-level of a valley incline *into* the hill or table-land which bounds it, or *outwards* towards the low grounds, determining whether machinery must be or need not be used—will oftentimes make a difference in the economy of mining the coal equivalent to the whole margin of average profit to be anticipated; and therefore no speculative anticipations beyond very vague and general ones are to be built upon any generalisations extended to unexplored lands, from those where the geological structure, mineral contents, and mining capabilities are already ascertained.

UNDULATIONS OF THE BASIN.

There are several features connected with the undulations of the Coal-measures in the Wyoming and Lackawanna Valley, which claim attention in any general survey of the structure and mining capabilities of this basin, or in any comparison of the resources of its different sections. Some of these concern the directions of the undulations with respect to each other, and to the course of the general valley which contains them; while others belong to the forms of the undulations, and the law of their steepening and subsiding.

1. The feature of widest generality connecting these anticlinal and synclinal waves, or saddles and troughs of the strata, is their remarkable approximation to parallelism throughout the entire range of the basin, irrespective of the bending course of the Main Valley and its

including mountains. This constancy in the direction of the waves, though singularly close, is not absolute, when those of distant sections of the valley are compared, there being a difference between the anticlinals of the vicinity of Wilkesbarre and those of the Lackawanna Valley of some 6°, the former ranging about N. 67° E., while the latter observe an average course of N. 72° or 73° E. It is, however, with few exceptions, strictly maintained among the flexures of the same district.

As a natural consequence of this approximate permanency of direction of the undulations, and the curving outline of the general basin, it is only in the lower or W. end of the valley that these rolls of the strata are parallel, or even nearly so, within the main course of the valley. There the chief groups among the anticlinals approach to a coincidence in direction with the mountain forming the S. side of the basin. Advancing N.E. to the Wilkesbarre and Pittston districts, this parallelism with the mountain border is more and more departed from, and with its progressive deflection to the N., along the S.E. side of the Lackawanna Valley, the obliquity of the undulations to the line of the basin and its barriers grows conspicuously greater. From the vicinity of Wilkesbarre, and probably from further W. the whole way to Carbondale, these anticlinals come forth in succession from the mountain-sides of the valley at larger and larger angles as we advance towards the N.E., the anticlinal waves, broad and flat on the slope of the mountains, pointing down obliquely W. into the valley, and contracting and growing steeper; while the synclinal troughs between them rise out of the central bed of the basin, flattening and shoaling up to the E., to disappear at higher levels on the same mountain-sides. This arrangement is discernible in the undulations of both sides of the basin, but those of the S.E. side being more numerous, of steeper flexure, and less obscured by diluvial drift, the feature is there more conspicuous. Each of the two mountain-barriers of the valley, with its set of anticlinal spurs passing off from it at successively increasing angles, may be likened to a curving fish-back, one concave, the other convex, sending out its spines or rays at increasing obliquities, but in mutual parallelism with one another.

2. A further general fact connected with these undulations of the Coal-measures—interesting for its geological bearings, and not less so for its practical consequences—is the curious declining gradation observable in the sharpness of the successive undulations as we proceed from S.W. to N.E. along the basin. Not only does each anticlinal of the S.E. side of the valley grow gentler or flatter in its dips as it slowly rises to the E., but the successive ones are fainter and fainter at the same proportionate sections of their length as we cross them obliquely in going towards the N.E. Those of all the lower or W. end of the valley, from Beech Grove to Nanticoke, show inclinations as high as 45°; those between Nanticoke and Wilkesbarre display dips exceeding 30°; and those between Wilkesbarre and Pittston, dips averaging 20° or 25°; while, following the Lackawanna division of the basin, we have no longer anything approaching this last steepness of flexure—except just near the ends of the saddles—but rather a low broad waving of the rocks, growing feebler and feebler as we advance, until, passing Scranton into the district between it and Archbald, regular undulations become almost imperceptible, and are lost in the very gradual dips into the middle of the general trough from the two borders of the valley. Accompanying this progressive smoothing-out of the waves or corrugations of the strata from the S.W. towards the N.E. end of the whole basin, there is a like gradual transition of declension in its external features, from sharp and narrow-crested ridges and deep hollows to

rounder and gentler spurs and valleys, and along the Lackawanna to wide-topped summits, bluffs, and open denuded plains.

3. Other points of general structure, appertaining to the interior undulations of the main basin, have reference to the prevailing *form* of the anticlinals and their troughs. A main feature in the individual waves is a progressive increase of flexure, or a steepening of the dips on both sides of the anticlinals as they advance from the mountain-sides, where they originate, out into the central tracts of the valley to near their terminations, which are therefore comparatively abrupt. Remarkably clear exemplifications of this structure present themselves to any close observer of the anticlinals between Wilkesbarre and the Lackawanna. If these be carefully traced from the E. down to this district, they will be seen to grow steadily sharper and sharper in their dips, until they approach in their oblique course to the banks of the Susquehanna, in the neighbourhood of which they nearly all subside by bluntly rounding off. In proof of this abrupt cessation, we have only to remark the contrast between the general steepness of these undulations, where they are crossed slantingly by the old stage-road, or even by the plank-road, and the extreme gentleness and absolute disappearance of many at the canal, and especially at the shore of the river. The very position in the valley which the river has taken, between the mouth of the Lackawanna and Wilkesbarre, is an evidence of the sudden dying-out of this Southern system of anticlinals. It would seem as if the waters, in scooping the lower valley or plain within which the Susquehanna flows, had been unable to pass the succession of barriers presented to them by these ridges in the strata, and were forced to recoil by the N. flanks and bold ends which the saddles protruded against them, swinging off in their rebound to follow the deflecting course of the waves of the strata towards the outlet of the drainage of the valley, the wide notch in the Northern mountain-barrier at Nanticoke.

The N. or N.W. side of the valley appears to have its own set of anticlinals or saddles, as already intimated; but whether these observe the same law in their oblique descent into the valley from the W. of a progressive increase of dip on both their flanks, I am not prepared at present to maintain, as the structure of this portion of the valley is largely disguised by surface drift, and as the points of many of the spurs or saddles are hid by the deep diluvium of the Wyoming and Lackawanna flats. All analogy, and every theoretical consideration of the origin of this curious feature in the anticlinals, would indicate, however, that the same steepening towards their terminations belongs to these waves, which characterises those coming from the opposite mountain lying E. Whether any of the flexures of the upper strata cross the basin entirely, passing W. from the Southern Mountain to coincide with undulations proceeding E. from the Northern, cannot be at present known; but the general cessation of both sets towards the middle of the basin is a strong intimation of the improbability of such a condition. The wood-cut here introduced displays one of the small flanks of the N. side of the basin known as Campbell's Ledge. It is a roll in the Seral conglomerate, exposed in the E. side of the gap of the Susquehanna. The face of the cliff, ranging nearly N. and S., is called also the Dial Knob.

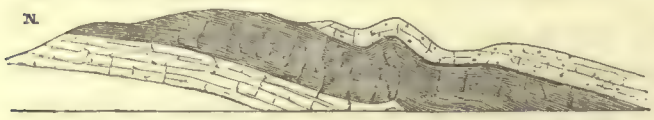


Fig. 257.—Campbell's Ledge above Pittston, Susquehanna Gap.

4. Besides the long parallel tapering anticlinal waves coming very acutely off from the mountain-borders of the basin, there are numerous shorter and narrower ones, having the form

of oval keels or saddles, which do not run into the mountains, but lie more or less insulated. Undulations of this class are more frequent in the central tracts of the valley than towards the sides, and their relative proportion to those of the longer form seems to increase steadily towards the upper or N.E. end, becoming between Scranton and Carbondale rather the prevailing type. In the uppermost parts of the Lackawanna Basin, we may indeed generally describe the flexures of the strata less as continuous waves or ridges than as successions of these elongated elliptical swells, some of them bulging into considerable steepness, but the chief part of them low and gentle waves, often too obscure to be detected externally in the topography, or in the dipping of the rocks, yet obvious in the mining of the coal, over which the feeblest undulations exert an almost tyrannic control, as regards the directions of the levels and gangways within the mines. It is a consideration of this important connection between the forms of the crust-waves and the whole economy of mining in our undulating coal-fields that induces me in this place to dwell so minutely on the several shapes which these assume.

5. There is still a lesser class of undulations in the coal-rocks, which the progress of mining in the region is constantly bringing to light, and which demand some mention here. These are the small irregular subordinate rolls, or short and narrow, but not always flattish wavings of the strata, on the flanks of the principal anticlinals. In some districts of the anthracite basins, these secondary flexures, whether on the backs or sides of the main saddles, or in the troughs between them, are for the most part parallel with the principal undulations which support them; but in the Wyoming and Lackawanna Coal-field, and other regions of oblique anticlinals, they are themselves acutely oblique to the axes of the great waves which sustain them. Their arrangement is somewhat analogous to that of the small feathers or plumelets on the side of a bird's wing; while the whole wing diverges and tapers from the body of the bird—the mountain boundary of the basin—these lateral lesser plumes diverge and taper in their turn from the main direction or axis of the wing. Wherever this structure prevails in its fullest symmetry, the mine levels or gangways, when extensive, will, in winding in and out on the sides, or at the foot of a chief anticlinal ridge, have that variety of the scallop form which we may call oblique, the convex loops all pointing in one direction—that, namely, towards which the main anticlinal is itself subsiding. These secondary rolls are numerous in the Great Mine of the Baltimore Company, near Wilkesbarre.

6. Viewing the undulations of the Wyoming and Lackawanna Coal-field transversely or in profile, they exhibit in the main the same feature of a preponderating steepness of dip on their North-western sides which characterises the chief part of the secondary flexures of the Pottsville Basin; but inasmuch as all the inclinations of the rocks of this Northern district are far gentler than those of that Southern coal-field, in the same proportion is the inequality less in the slopes of the opposite sides of the anticlinals, until, in the Lackawanna Valley and other very gently undulated districts, the difference in an average of several waves is almost imperceptible. The general trough-like structure of the valley in these sections disputing its influence on the inclination of the strata with the local flexures, the undulations of the S.E. side of the basin show their steepest dips to the N.W., or towards the bed of the valley, while those of the N.W. side exhibit theirs on their S.E. flanks, or towards the same controlling synclinal line. In the W. end of the Wyoming Valley, the undulations being there sharper, the general law of inequality in the slant of the sides of the waves is much more conspicuous than in the

Lackawanna Valley, where all the flexures are flatter, and where local swells have a relatively greater power to disguise the existence of any general law of form in the undulations.

Having in the foregoing paragraphs unfolded as succinctly as was compatible with clearness the general characteristics of the structure of the curiously-fashioned beautiful coal-field of the North Branch of the Susquehanna, it is incumbent on me to offer now a more special and minute description of the better developed districts of the valley.

THE COAL-MEASURES.

It has been already stated that the coal-containing strata of the coal-field generally appertain to the White-Ash Coal-measures of the anthracite basins; and it was also remarked that this group exhibits greater fluctuations in the dimensions and quality of the coal-beds than any other subdivision of the whole coal-formation. These fluctuations, it is appropriate to add, belong equally, or in a greater degree, to the rocks which fill the intervals between the coal-beds. It would seem as if the physical conditions under which these earliest coal strata were deposited, were more inconstant than those which belonged to the later stages of the formation. The spaces over which the nearly perfect state of repose of the surface prevailed, necessary to the accumulation by slow growth of the vegetable peaty mass producing each seam of coal, were evidently of a narrower geographical extent than afterwards; and the currents and disturbances of the earth's crust, which buried these successive peat-swamps under the clayey, sandy, and even coarse gravelly strata that rest upon or between them, were obviously much more violent than in the middle and final ages of the great coal period.

Nowhere, perhaps, in the anthracite country, are the proofs of this instability of the surface during the first stages of the coal-formation more conspicuously manifested than in the Wyoming and Lackawanna Basin. Here we find, in certain neighbourhoods, in the same few hundred feet thickness of the lower coal strata, as many as ten or twelve separate beds of coal, while in other localities there exist not more than half, or even a third of this number; and what is more material, the very same individual bed which in one quarter possesses an ample or indeed superabundant thickness, is in another only a dwindled seam, too thin or too impure for profitable mining. Without attempting any close continuous tracing of the several coals, which can only be done when the district shall have become much more extensively mined, I may exemplify the variability of these Coal-measures by appealing to the very different types which they assume in the three meridians of Solomon's Gap, S.W. of Wilkesbarre; Spring Brook, S.E. of Pittston; and the vicinity of Scranton.

At Solomon's Gap, the group of lower White-Ash Coal-measures (see Fig. 255, p. 322), extending from the foot of the mountain N.W. across the basin, to the edge of the diluvial flats of the Susquehanna, includes in a thickness of 900 or 1000 feet as many as *thirteen* beds of coal of various sizes, from 1 foot to 19 feet; and the total thickness of coal, fit and unfit for mining, embraced by this section, may be estimated at nearly 84 feet. But out of this aggregate quantity, the thickness susceptible of being profitably wrought does not probably amount in all to more than 45 or 50 feet. Traced E. and W., these coal-beds undergo, even in the space of 2 or 3 miles, some very remarkable variations. Thus the fifth in position from the bottom enlarges in that distance from a thickness of 17 feet at Solomon's Gap to the noble bulk of 28 feet opposite

to Wilkesbarre, beyond which neighbourhood it seems again to decline even more rapidly than towards the S.W. These fluctuations arise partly through the coalescing of two or more beds into one, or, conversely, through a splitting and diverging of the thicker seams into two or three thinner ones; or partly, again, by the gradual alterations of size of the same coals, independently of such unions and subdivisions.

If we turn now to the district of Spring Brook, we shall find all the features of the formation so altered as to present not one subdivision, neither coal-bed nor other stratum, which we can recognise or identify as a member of the series visible in the vicinity of Solomon's Gap. In a total thickness of several hundred feet of Coal-measures, embraced between the outcrop of the Main Pittston Seam and the conglomerate of the mountain to the S.E., only six coals in all, according to the largest estimate, have ever been brought to light, after close and persevering researches, and only two of these appear to have a size and purity adapting them for successful mining. There would seem to take place between the neighbourhood of Solomon's Gap, or Wilkesbarre, and this quarter, a progressive impoverishment of these lower strata in the number and size of their included coal-beds, and likewise in the rocks themselves, which thin down considerably. As a consequence, this portion of the Southern skirt of the valley contains no collieries of any magnitude.

Another and opposite change back to a very productive condition of the Coal-measures, is exhibited as we continue our progress along the same side of the basin N.E. up the Lackawanna Valley to the vicinity of Scranton.

We proceed now to a detailed examination of the basin, beginning, as usual, at the N.E. extremity, and proceeding towards the S.W.

Subdivisions of the Coal-field.—The whole Northern coal-field thus sketched may, for convenience, be subdivided into five districts, the limits of which are, however, somewhat arbitrary. Proceeding from N.E. to S.W. these are:—

1. *The Carbondale and Archbald District.*—This extends from the N.E. extremity of the basin, 7 (?) miles above Carbondale, to the vicinity of Jessup, W. of Archbald. It is 15 or 16 miles long, and expands from a narrow point to a breadth at Archbald of more than 4½ miles. Though wide, it is obviously very shallow, containing even at its lower end only from 300 to 400 feet of thickness of the coal strata, and in some belts much less. Its flat floor is gently and irregularly undulated, the anticlinal flexures in some places, as at Archbald, actually lifting the rock below the coal into view.

2. *The Scranton District.*—This division of the basin, in the centre of which is the town of Scranton, lies between Jessup on the N.E. and Spring Brook on the S.W. Its length is about 12 miles, and its average breadth, between margin and margin of the coal-rocks, is not less than 4½ miles. It is traversed by more decided and longer undulations of the strata, its more Southern anticlinal axes being individually traceable. The Coal-measures of this district are deeper than further up the valley, and the number of separate coal-beds amounts in the deepest parts to about ten.

3. *The Pittston District.*—From Spring Brook to Laurel Run a third somewhat natural segment of the coal-field may be recognised, which I propose to call the Pittston District. It is between 9 and 10 miles long, and expands from a width of 4 miles, which it has at Spring Brook, to one of 5½ miles at Laurel Run. It contains its own group of flexures of the strata, which are

numerous, long, straight, closely approximated, and nearly parallel. It differs from the district N.E. of it in containing a higher group of coal-seams, and therefore a thicker body of Coal-measures.

4. *The Wilkesbarre, Nanticoke, and Shickshinny District.*—This rather natural division of the coal-field, extending from Laurel Run to the W. end of the basin, and lying S. of the Susquehanna, has a length of about 18 miles, and contracts from its maximum breadth of 4½ miles at Wilkesbarre to a mere point W. of the intersection of the river. In the vicinity of Wilkesbarre this district embraces the thickest body of Coal-measures within the coal-field, and therefore a greater number of coal-seams, having apparently two or three seams more than belong to the Pittston district (unless, indeed, at Port Griffith). Westward the basin grows more and more sharply undulated, and approaching Shickshinny, its surface, from this circumstance, and from excessive erosion, is roughly and wildly curved and gashed.

5. *Wyoming, Kingston, and Plymouth District.*—This is the slender belt of the coal-field which lies N. of the Susquehanna, or between it and the Shawnee Mountain. Nearly one-half of it is superficially covered with a deep stratum of diluvial and alluvial matter effectually hiding the Coal-formation, while the other or N. half presents a very accessible strip of the Coal-measures at the base and in the gentle much-channelled slope of the mountain. It contains the lower coal-beds moderately undulated by a series of short, rather feeble, parallel anticlinal flexures.

CHAPTER II.

CARBONDALE AND ARCHBALD DISTRICT.

Valley N.E. of Carbondale.—The topographical features of the valley of the Lackawanna above Carbondale are quite simple. Upon either side of the river the land rises in a succession of slopes, with intervening terraces or benches, to the mountain-summits bounding the basin on the E. and W. It is as yet an undeveloped region, and is covered for the most part by a dense growth of forest. But few explorations have been made in this upper district, and they have not led to any very encouraging results. In the absence of reliable data our notice of it will be brief.

From the position occupied by the Seral conglomerate upon Fall Brook, upon the W. or N.W. side of the basin near Carbondale, it would appear to hold its place not far from the crest of the mountain on that side of the basin, as far N. as our general Map of the region has been prolonged. It evidently does not rise out in basin form for some distance further N.; owing, however, to its gentle inclination on both sides of the valley, and perhaps to one or two rolls which elevate the more central trough, the basin must be shallow, and there is little hope of finding in it any great thickness of valuable Coal-measures. On the E. or S.E. side of the basin, the conglomerate found upon the hill-face, among the back streets of the town-plot of Carbondale, passes near the

foot of Plane No. 3 of the Delaware and Hudson Company's Railroad, and follows the inner ridge of the mountain bounding the basin on the E.

On lands held by Mr Woodman, situated 6 miles above Carbondale, diggings have been made to find coal. Several seams have been struck; the thickest coal visible did not exceed 5 feet, and displayed a very rough peculiar texture, making it of little value. It is possible that in the progress of research more hopeful results may be attained, though our explorations hold out no very flattering encouragement.

Of the Lackawanna Basin from Carbondale southward.—Coming now to the Carbondale district of the Lackawanna Basin, we are guided to much more satisfactory and positive results by the extensive mine-workings of the Delaware and Hudson Coal and Canal Company. This corporation holds large tracts of land in the valley as far S. as Archbald, where it is also largely engaged in the mining of coal. Between Archbald and Carbondale, coal is transported over a railroad 8 miles in length, so inclined as to permit the cars to run by gravity. Upon the same principle, the empty cars are returned upon another road to the point of departure. From Carbondale the coal finds an outlet to market by a series of planes, and a gravity-road over the mountain to Honesdale, whence it is shipped upon the Delaware and Hudson Canal to the tide-water.

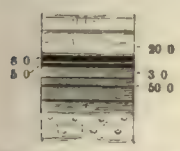


Fig. 258.—Coal-measures at Carbondale. 1 *inch* = 200 *feet*.

By a reference to our column of the stratification in the vicinity of Archbald, it will be seen that there are enumerated the four coal-seams of workable dimensions. Of these only two are found at Carbondale, and upon the upper and larger of the two, mines are established.

Below the great bed are two smaller coals, equivalents of those shown in the Section at Archbald. The lower of these lies close to the conglomerate, and measures 18 or 20 inches. It may be seen near the falls of Fall Brook. The upper is larger, measuring 3½ feet in thickness. It has been found on Racket Brook, near Mr Charles Wurtz's house.

The basin of the Big Coal is a broad and simple one, the dips on both sides being quite gentle, and uninterfered with by anticlinal rolls. Its centre line or axis bears about N. 25° E., and S. 25° W. From the neighbourhood of Shaft No. 2 on Coal Brook, it passes about 300 feet W. of the "New Slope" at the Montrose Road, about the same distance from the "New Mine" Slope, and thence under the plank road, near the crossing of the "loaded" track, to the new mine, No. 3, at the high trestling. From this line it rises out to day on its Westward dip in the bluff on the N. side of the river, where several mine-mouths enter it. Denudation has carried away this valuable coal in the immediate valley of the river at Carbondale, nor is it found in the rising-ground back of the town. Its dip is so gentle that it was found in the hill which supports Plane No. 1, N.E. of the town, and it has been mined to some extent by Mr Clark and others.

Addressing ourselves now to the line of outcrop of the great bed, we may trace it as follows: From a point S. of Shaft No. 2, it occupies the face of the low bluff bordering the flats of the Lackawanna; passing the "New Slope" and the "New Mine," it runs parallel to the river to the "Dip Mine." Thence it deflects Southward, crossing the river, and passes Eastward along the river for about 1000 feet; again it turns Southward for another 1000 feet to the slope of the hill overlooking Powderly Creek. Along this hill-face, from the loaded track at the high trestling, it passes parallel to the creek and the empty track of the railroad to the Powderly branch-road.

It then crosses the valley of the creek above the tunnel, Mine No. 3, and, passing the Powderly Mines, is lost in the high wooded lands to the South. On the N. side of the basin it has been opened near Fall Brook at Brennan's Mines, at the old Fall Brook Mines, and on the S. side of the river, near its brink, at Shaft No. 1 of the Company. Westward of the latter point, on the N.W. side of the river, Meredith has opened it, and it has been proved at several localities between Meredith's and the gorge of Rush Brook 2 miles further S.W. Throughout all this district it retains its dimensions as a valuable bed of coal.

Of the thickness, subdivisions, and character of the great bed itself, we present the following particulars. Taking it at a point where all its component parts are in full development, we have the following :—

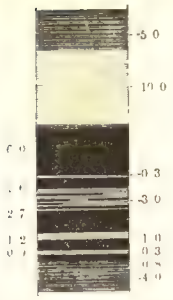


FIG. 259.—Great Bed, Carbondale.

	Feet.	Inches.
Coal and slate in alternate laminæ,	5	0
Slate,	10	0
Coal and slate	1	0
Coal, of good quality,	6	0
Slate,	3	0
Coal,	1	6
Coal, bony (argillaceous), divided by slate,	3	0
Coal,	2	7
Slate,	1	0
Coal,	1	2
Slate,	0	3
Coal,	0	9
Slate,	0	8
Slate and coal,	4	0

The middle slate or bony bench is sometimes only 2 feet thick, but at the Powderly Mines, in the further workings of the old gangways, it amounts to 5 feet in thickness, whereas at the mine's mouth it is not found. At these mines the upper bench of coal is somewhat impaired by bands of slate. We shall presently have occasion to advert to the fluctuations in the dimensions of this coal traced further down the valley. At the high trestling over Powderly Creek, a boring is reported to have been attended with the following results :—

	Feet.	In.		Feet.	In.
Coarse thick-bedded sandstone—			Coal, bony,	2	3
calamite impressions,	16	7	Coal,	1	6
Slate, thin coal in it,	1	10	Slate,	0	2
Coal, pure,	5	7	Coal, divided by two thin slates,	5	5
Slate, compact,	?	?	Shale,	...	
Coal, pyritous,	2	4			

At this point the uppermost beds of the conglomerate were found 50 feet below the main coal. Our data place it at the somewhat variable distance of from 50 to 75 feet below the great seam ; and at Archbald it is estimated to be rather more than 100 feet below that bed.

To obviate the necessity of a recurrence to the topic, it will be expedient to define in general

terms the position held by the conglomerate on both sides of the valley, as far South-westward as the parallel of Legget's and Cobb's gaps.

On Fall Brook, N.W. of Carbondale, it displays itself at the foot of the falls, where the waters of the stream pour from a great height over its upper beds, capped by coarse grey sandstone. Above the falls it soon rises out in conspicuous ledges upon the E. side of the brook. Many of its beds are unusually massive, and contain pebbles as large as hen's or even turkey's eggs sparsely bedded in a sandstone paste. From this point traced S.W., it occupies a position high on the mountain bordering the valley on the N.W. On every traverse made upon the mountain, it was found to hold this position. Such is the case in the shallow notch W. of Carbondale, through which the road to Scott Township passes. It is likewise found at the water-level in the thorough-cut gorge of Rush Brook, not far N. of the Old Carey Coal-opening, and it has the same place in the wind-gap from which Tinklepaugh Creek descends into the valley. It forms the inner ridge of the mountain at the Greenfield Notch N.W. of Lillibridge's, and throughout the distance to the gap of Legget's Creek it everywhere supports the high ground of the upper rise of the mountain.

Passing now to the uncleared tracts on the S.E. side of the valley, the conglomerate boundary of the basin is much more obscurely defined. It appears to be influenced by several rolls in the strata, which, taking their origin in the mountain, strike obliquely across the valley, at first boldly elevating the conglomerate, but gradually declining, to permit the Coal-measures to wrap round their ends, and fold over their summits. At Carbondale, as we have before indicated, it lies close at the back of the town. It flanks the hill S. of Powderly Creek, where that stream flows longitudinally along the valley, and is found in the neighbourhood of Grinnel's Sawmill, though there are some reasons for believing that it is influenced by one of the anticlinal rolls alluded to, which throws it into the ground again, and produces perhaps a shallow coal-basin in the lands S. of the mill. Above Archbald, and between it and the Great Western Sawmill, we find the conglomerate exposed in massive ledges near the water-level in the hills on both sides of the river, though it again comes out to day as much as 2 miles up White Oak Run, E. of Archbald. There is therefore every reason for believing that coal exists S. and E. of the Delaware and Hudson Company's mines at Archbald. We again find the conglomerate on the old road from Jessup to Cobb's Pond, some distance S. of Noble's or Sterick Creek. From this point, through the wilderness country to Roaring Brook, it has not been followed, though it seems to encroach more upon the valley, perhaps owing to the influence of the great anticlinal of the Dunmore Ridge ; and it appears on Roaring Brook at the mouth of Little Roaring Brook, where we will leave it until we come to describe it in our treatment of the Scranton District.

Of the structural features of the Lackawanna Coal-basin, between the Carbondale district and that of Scranton, we are unfortunately unable to present many particulars. The wide distribution of diluvial matter which conceals the strata on the cleared lands along the river, and the wild and inaccessible nature of the more Southern country, taken into consideration, with the limited amount of mining or exploratory shaftings, greatly interfere with our presenting a clear and connected account of the distribution of the strata.

Between Archbald and the Great Western Sawmill there are indications of a broad flat roll of strata, which brings the true Seral conglomerate above water-level. Of its origin E. we know

nothing, nor have we any guide to its character W. In the latter direction, however, its bearing carries it through the high table-land N. of Archbald.

A second disturbance is that encountered in the working of No. 4 Drift Mine. Though it has somewhat the character of an abrupt upthrow of the strata, it is usually considered a fault. In mining coal from the above-mentioned drift, an upthrow of 12 feet to the S.E. was encountered. Following the coal along the uplift a distance of about 440 feet at right angles, it is thrown down S. 60 feet at an angle of 25°. The upthrow and downthrow bear parallel to each other in a direction S. 65° W. The first, crosses near the head of the Upper or No. 2 Plane; the other, near the foot of the same. The true bearing of the anticlinals of this part of the valley is thought to be about N. 70° E., or S. 70° W. Comparing this with the bearing of the main basin at Carbondale which we have given, it will be seen that the difference is about 45°. We have here evidence that the flexures of the two districts belong to different groups: while in the one case the basin appears to emerge from the mountain on the N.W., in the other the anticlinals are prolonged from the S. barrier.

A third anticlinal roll is that met with a few hundred feet S. of the mouth of Laurel Run, where it crosses the river. The prolongation of this anticlinal W. carries it near Water's Sawmill, at Mount Vernon, below which the dips are W., plainly indicating its declension W. The same fact is proved by the deflection of the gangways of No. 1 Mine at Archbald.

Archbald.—The accompanying vertical column of the strata at Archbald, comprising data obligingly furnished by Mr Jones, Superintendent, will exhibit the stratification of the vicinity. The Seral conglomerate proper is a massive rock made up of pebbles of a large nut-size. This stratum is not more than 20 or 30 feet thick. Below it reposes a thickness of fully 30 feet of pure white sandstone. A rock of the same character, and holding the same position, was seen in the notch of Tinklepaugh Creek on the mountain upon the N.W. Below this rock a boring was made at the Great Western Sawmill Dam. A coal 8 inches thick was reached, but no others were met, though the boring was continued many feet. Close above the conglomerate, a thin coal, from 12 to 18 inches thick, has been found. It is to be seen below the "empty track" near Farnum's Mill-dam. This is succeeded by 80 feet of coarse micaceous sandstone, capped by an impure worthless coal 4 feet thick. About 27 feet of sandstone and shale strata intervene between this and the main great bed, which measures not less than 10 feet in thickness. Succeeding the great bed, 30 feet of sandstone strata are found supporting a coal which is sometimes wanting, though at others it exceeds 18 inches in thickness. Upon this rest 7 feet of shale, overlaid by 55 feet of sandstone strata, which brings us to a coal 4½ feet thick, but not generally of good quality. The next coal measures 18 inches, and is separated from the former by 44 feet of sandstone. A thickness of 17 feet of shale brings us to the highest coal of the district. It caps only the highest ground where the structure favours it: it measures 7 feet in thickness, and is of good quality, but is usually too near the surface to be workable. It is the equivalent of the Grassy Island Coal, worked by the slope and the lower shaft at Jessup, and is thought to be the same as that opened by Squire Callender, near his house, on the old turnpike to Carbondale.

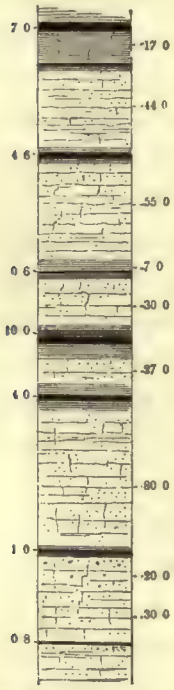


Fig. 260.—Columnar Section at Archbald.

The following are the subdivisions of the main bed at the mines of the Delaware and Hudson Company, and the opening of Mr Hackley at Archbald :—

	Feet.	In.		Feet.	In.
Coal, . . .	2	6	Coal, . . .	1	6
Slate, . . .	0	1½	Slate, . . .	0	2
Coal, . . .	0	6	Coal, . . .	5	0
Slate, . . .	0	2			

We find that the apparent equivalent of the Eight-feet top coal at Carbondale has thinned down to 2 feet 6 inches ; this appears to be owing to the encroachment of the slate upon the coal, which it replaces. In the Powderly Mines there are indications that this is the case. The nett yield in the mines at Archbald does not on an average exceed 5 feet. Over this large seam, upon the N.W. side of the basin, a conglomeritic rock 20 feet thick has been seen ; the same stratum is thinly developed at Hackley's Mine near Archbald, but at the Company's mines it has thinned away.

At Mount Vernon, upon the river, 2 miles S.W. of Archbald, the series of coals indicated in the column have been opened. The lowest bed proved is the equivalent of the Four-feet Coal. It measures 9 feet, inclusive of a band of slate from 18 to 24 inches thick, which divides it. The whole bed is slaty, though parts have been selected for mining. Its place is above the sawmill dam. In the slates beneath this coal, immense nodules of iron-ore are met with, sparsely scattered and firmly imbedded. The second bed is opened behind Mr Water's barn. At the outcrop it is but 4½ feet thick, but in the mine it measures upwards of 6 feet. On the W. side of the river, at about the same level, a large coal has been proved, but not for its entire thickness. It is thought to be the large bed. Iron ore has been found under this bed. About 30 feet above the last bed a 3-feet coal-seam has been proved, and high on the hill the upper coal, 6 feet thick, has been found.

At *Jessup*, situated near Grassy Island Creek, about a mile from Mount Vernon, are located the mines of the Lackawanna Railroad Company. The upper 7-feet coal, entitled the Grassy Island bed, and the lower main seam (the Seymour beds), are wrought. They are separated by 180 feet of strata. The upper shaft, now abandoned, penetrated 165 feet to the Seymour Coal, in which it displays the following dimensions :—

	Feet.	In.		Feet.	In.
Coal, . . .	0	8	Coal, . . .	4	0
Slate, . . .	0	3	Slate, . . .	0	6
Coal, . . .	2	0	Coal, purest, . .	2	0
Slate and Coal, . .	0	8			

In the lower shaft, the upper coal was met at a depth of 18 feet. Both of these shafts were located upon a Northward-dipping bed, and owing to this mistake in the lower shaft, the Company were under the necessity of sinking lower, and tunneling forward to the coal, in order to gain a working breast. The tunnel was driven at a depth of 40 feet. A slope-mine enters upon the same seam at the head of the lower shaft. The dip in this slope is 9° at the top, steepening to 14°.

The following are the subdivisions of the upper or Grassy Island Coal :—

	Feet.	In.		Feet.	In.
Coal,	1	6	Parting,	...	
Slate,	2	6	Coal,	1	0
Coal,	1	2	Slate,	3	0
Parting,	...		Coal,	1	0
Coal,	3	4			

It crops out near Jessup on Grassy Island Creek, whence its name.

The lower shaft was sunk 160 feet below the upper coal, to a coal-bed 3 feet thick, supposed to be about 20 feet over the lower bed.

The Seymour Coal bed crops out on the S. margin of the flat ground back of Jessup, but in its course South-westward it gradually climbs the hill. On the E. end of the same hill, the Seral conglomerate crops out at the Grassy Island Creek. On Noble's or Sterick Creek, back of this hill, a small coal is found making the bed of the stream ; it is one of the lower coals.

The basin of the Jessup Coals is estimated to be about 800 feet N.W. of the slope. At this point the upper coal should be quite accessible to a shaft.

Crossing to the N.W. side of the valley, we will notice the few developments there made. These are chiefly made upon the lands of the Tinklepaugh Coal Company, who are making investigations previous to the establishment of collieries. Their lands lie upon the mountain bordering the valley on the N.W., and are S. of the notch of Tinklepaugh Creek, which passes through the property. By a series of borings, seven in number, they have established the position of the coal which they proposed to work. This is the Callender Seam. In one of the borings this seam, measuring 10 feet, including its slates, was passed through, and 7 feet beneath it, a small coal from 15 to 18 inches thick was proved. This bed is always found, though at somewhat variable distances, under the larger coal. Between 80 and 90 feet below the large coal, a bed, measuring 6 feet, is said to have been bored through. A tunnel is about being driven into the mountain from the W. side of Tinklepaugh Creek. It is estimated that the Callender Coal will be struck 300 feet from the mouth. High on the mountain, a drift enters upon coal of the following dimensions :—

	Feet.	Inches.
Coal,	5	6
Fireclay,	2	3
Coal,	3	6

Upon Dodd's Farm, high on the mountain S.W. of the Tinklepaugh Mines, several coals have been met with. Three of these, measuring respectively 2½ feet, 1 foot, and 8 inches, beginning with the lowermost, have been met with in a tunnel driven Northward 115 feet. The dip is from 25° to 30° S. Lower down on the flats, Richmond's coal-bed displays 3 feet of slate and coal. In the same neighbourhood is Callender's Mine.

On the S. side of the river, upon the lands of Samuel Ferris, in the bed of a ravine, two coal-beds have been mined to a limited extent. The upper coal is about 6 feet thick, and dips Southward very gently. In the slates beneath this coal-bed are found impressions of the beautiful fossil *Neuropteris Clarksoni* of Lesquereux. Superb specimens repose in the cabinets of Mr Clarkson of Carbondale and Mr Jones of Archbald. The lower coal dips Northward, but the

drift-mouth is closed. Half a mile further Westward, Mr Hull has opened a fine bed of coal, which has been mined for use in the neighbourhood. Its subdivisions are given :—

	Feet.	Inches.
Slate and shale overlaid by mealy sandstone,	15	0
Coal,	1	0
Slate parting,	...	...
Coal,	1	6
Parting,	...	...
Coal,	1	0
Parting,	...	...
Coal,	1	6
Slate,	0	2
Coal,	2	0
Fireclay,	...	

Fig. 261. — Hull's Coal, 6 miles N.E. of Scranton.

On the line of the main road to Dunmore, coal has been opened at various points, but the mines are most of them closed, and no regular series of shaftings have been made to enable us to identify the coals. Among the coals seen may be mentioned a 10-feet seam in the bank of Noble's Creek, above Dr Crandell's Sawmill, nearly under the Lackawanna Railroad crossing. It dips 10° N. Upon Mr Anderson's farm, and the farms adjoining, several coal-seams have been proved, varying from 3 feet to 7 or more feet in thickness. N.W. of Mr Anderson's house, and near the Plank Road, Mr Chittenden is now conducting the operations of a deep shaft, which is being sunk to the supposed equivalent of the Big Seam of Scranton. In the orchard W. of the shaft a coal 8 feet thick has been drifted into. A boring near by, which penetrated to a depth of 300 feet, is said to have cut a coal 2½ feet thick, 100 feet from the surface, a 5-feet coal at 115 feet, and a large seam at 300 feet. We were unable to procure the particulars of this boring. There are indications of an anticlinal and synclinal roll of the strata on the road between Chittenden Village and Mr Anderson's, upon the S. side of the river. The prolongation W. of this anticlinal would carry it a little S. of the hill at Providence. A shaft sunk by Carter near Capouse, cut a coal 6 feet thick, at a depth of 30 feet from the surface. On the W. side of the river, opposite this point, there are several old coal-openings upon a bed said to be 4 feet thick, and dipping N.

We can present no further particulars of the basin of the Lackawanna N. and N.E. of Dunmore and Providence ; enough has been said, however, to establish the fact, that the basin has been gradually deepening all the way from Carbondale, and contains a constantly increasing thickness of Coal-measures.

We now come to a systematic and careful treatment of the stratification of the basin, and of its structural features, as they are exhibited in the vicinity of Scranton.

CHAPTER III.

COAL-MEASURES OF THE SCRANTON DISTRICT OF THE LACKAWANNA BASIN.

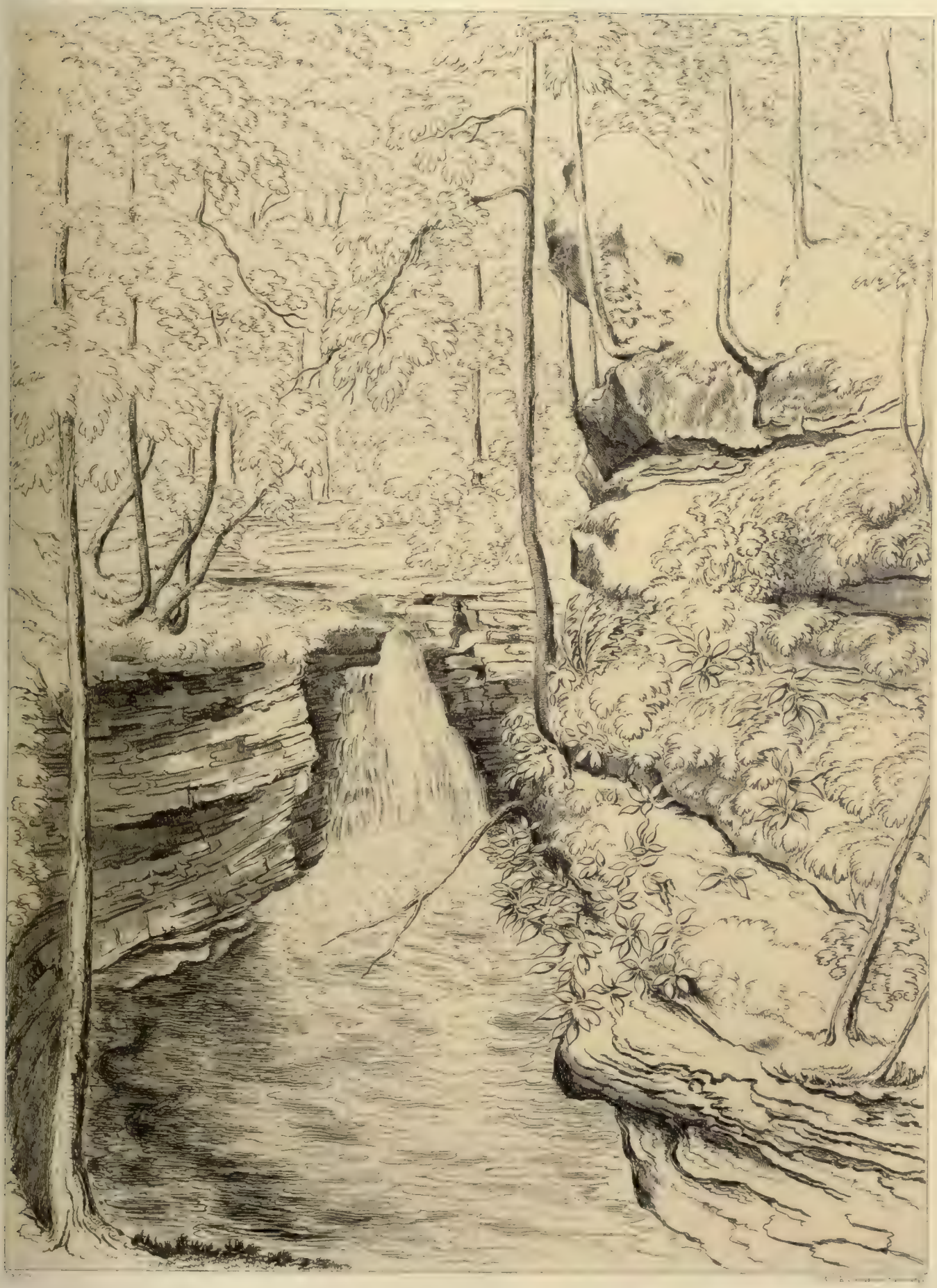
THE Seral conglomerate in the vicinity of Scranton is a coarse massive white and grey pudding-stone, consisting of two members : the lower of these, between 70 and 80 feet in thickness, is composed of coarse pebbles, of the average size of a hazel-nut, of white quartz and grey sandstone intermingled, compactly imbedded and cemented in grey and white quartzose sand, and disposed in thick and ponderous beds from 6 inches to 10 feet in depth. The upper member also, about 80 feet thick in the vicinity of Scranton, is a finer-grained and whiter rock, a quartzose pebbly coarse sandstone, alternating with dark-grey sandstones, rather than a true conglomerate. The lower of these divisions alters its dimensions in passing under the old basin, appearing on the N.W. side only 40 feet thick. The other retains its bulk, which in different localities varies from 60 to 90 feet. In certain remote districts of the basin there are indications of a thin seam of coal in the shales, sometimes parting these two members of the conglomerate, which is a sufficient fact, apart from the identity of the rock with other conglomerates included among the true Coal-measures, for ranking this great underlying stratum as a part of the true coal-formation.

It is not easy, in the present state of mining, and the development of the Lackawanna Coal-field, to estimate with exactness the aggregate thickness of the productive Coal-measures in the vicinity of Scranton, nor even to compute the precise number of useful beds of coal for every locality ; nevertheless we shall not go far astray in estimating the coal-rocks in the more central parts of the basin to have an aggregate thickness of about 500 feet, measuring from the upper limit of the conglomerate to the highest sandstones capping the table-land between the valleys of the Lackawanna and Keyser's Creek. The total number of the coal-seams included in this mass of strata is not less than *twelve*—possibly, indeed, there may be one or two more. This is without counting the subdivisions into which some of them separate in certain localities. Upon the basis of their lowest average thicknesses, the whole series constitutes a depth of coal of 59 or 60 feet ; and I am disposed to estimate the total thickness of the coal available for market, where all the strata are in the ground, at about 40 feet. It will thus be seen that the measures in this vicinity are to be regarded as uncommonly rich in coal. Eight feet of coal to the hundred feet of strata, which is a little below the true proportion here, is above the ratio found in most coal-fields. This fact, taken in connection with the prevailing low dip, approaching to horizontality, gives facility for reaching a large amount of fuel by perpendicular pits or shafts.

It is only in the higher grounds of the central portion of the basin that the uppermost coals exist at all ; elsewhere the higher measures have been removed by a greater or less depth of denudation.

THE INDIVIDUAL COAL-BEDS, AND THE STRATA WHICH SEPARATE THEM.

In describing the individual coal-beds and the strata intervening, it will be expedient to give a general account of them before entering upon the more detailed statement of their local distri-



ROARING BROOK FALLS NEAR SCRANTON.

bution and character. Only those seams of coal will be enumerated which are of notable thickness and have a practical value. (See vertical column of the strata at Scranton.)

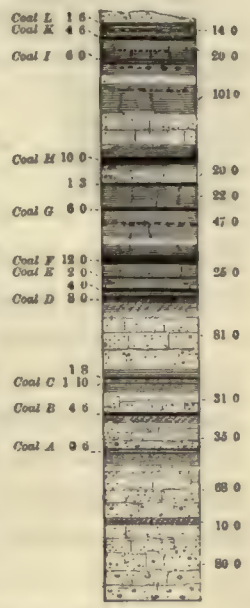


FIG. 262.—General Section of the Coal-measures at Scranton.—1 *inch* = 200 *feet*.

Observing the ascending order, the first coal-bed which presents itself is—

Coal A.—This, the lowest coal-seam of the series, lies immediately over the upper division of the conglomerate. On the S.E. or Scranton side of the basin, it is generally a double but thin seam, the two divisions being separated by 3 or 4 feet of blue sandy shale or impure fireclay, full of the rootlets of Stigmaria. The lower layer is usually from 1 to 2 feet thick; the upper averages about 1 foot. In the immediate vicinity of Scranton this bed is nowhere suitable for mining; but at Dunmore a coal evidently corresponding to it has been mined to a small extent at Plane No. 6 of the Pennsylvania Coal Company's Railroad. It has there a thickness of about 5 feet, and dips gently N. Succeeding Coal A, which is overlaid by a thin layer of shale, there occurs a coarse conglomeritic thick-bedded sandstone, surmounted by a bed of shale; the whole is about 35 feet thick on the S. side of Roaring Brook.

Coal B.—This seam has an average thickness, in the vicinity of Scranton, of about 4 feet 6 inches. It is mined on Roaring Brook, where it displays a bottom bench 3 feet 2 inches in thickness, overlaid by 2 inches of slate, succeeded by a top bench of 14 inches of rough coal. At Plane No. 6 it is between 5 and 6 feet thick, and is successfully mined. Under this coal is a bed of fireclay 5 feet thick, containing rootlets of Stigmaria.

Immediately upon Coal B reposes a thin-bedded micaceous sandstone, obliquely laminated; and upon this about 11 feet of coarse Stigmaria shale, succeeded by fireclay, which constitutes the floor of the next coal; the whole interval between Coal B and this latter being about 31 feet.

Coal C consists of two benches, the lower 17 inches, the upper 22 inches thick. At Dunmore, where it has been mined to some extent in the hill supporting Plane 6, its total thickness is nearly 5 feet. At Spencer's Mine it contains 4½ feet of good coal. On Roaring Brook the two divisions of the bed are separated by 6 feet of Stigmaria shale.

Directly overlying the roof-slate of Coal C is a mass of thick-bedded obliquely-laminated sandstone, in all about 70 feet thick, and upon this about 12 feet of shale, the upper 3 feet of which is fireclay, imbedding the usual Stigmaria rootlets. These intervening measures have a total thickness of 80 or 82 feet.

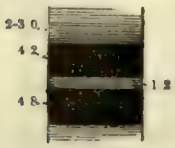
Coal D.—On Roaring Brook this is generally a double seam, the lower bench measuring from 6 to 7 feet, the upper, sometimes called the Four-feet Seam, varying from 1 to 6 feet.

On the N.W. side of the basin, in the vicinity of Legget's Gap, it has been opened at several points.

Clark's Mines are dependent upon this coal-bed, and the New York and Pennsylvania Coal Company are about to work it from a tunnel driven back from their slope on the Big Coal (F) above it.

Capping Coal D is a sandy micaceous shale 5 feet thick, succeeded by 10 feet of rough fireclay, imbedding large globular masses of clay iron-ore, or argillaceous carbonate of iron. The nodular masses of the ore are generally 2 or 3 feet in diameter, distributed in one layer, sometimes nearly in contact, but more usually 2 or 3 yards asunder. The interval between D and E is on Roaring Brook from 12 to 15 feet.

FIG. 263.—Coal F (Big Bed), New York and Pennsylvania Company's Slope Mine.



Coal E.—The next coal in the series seems to be of variable dimensions. On Roaring Brook its thickness is about 20 inches; but at the Lackawanna River, a little W. of the Bellevue Mines, a bed occupying the position next beneath the great seam F, has a far greater size, containing, indeed, some 8 feet of coal of different qualities.

Resting upon Coal E, and constituting the floor of the next superior bed, called from its large size the Big Coal, there is interposed on Roaring Brook a bed of black slate, shale, and micaceous shaly sandstone, varying in thickness from 7 to 12 feet.

Coal F.—This large and valuable bed of coal, measuring in the different localities around Scranton, where it has been cut, from 11 to 14 feet, and even 18 feet, is not a simple seam, but usually consists of two or three or more benches. On Roaring Brook, where the seam has its most South-eastern outcrops, its thickness is about 13 feet, and this appears to be about its size in the boring carried down from the bottom of Shaft No. 2 at the Diamond Mines. It is of like dimensions at the Pinebrook Mines, but further S. on the river it is considerably thicker, being 18 feet in depth, including its parting-slates. The details concerning this coal will be presented hereafter.

Interposed between the Big Coal F and the next succeeding seam there occur from 55 to 60 feet of strata, consisting, first, of a sandstone resting on the roof-slate of F, then a considerable thickness of sandy slate and shale, then a thin laminated sandstone, and above this shale or impure fireclay, forming the floor of the coal-seam G. At the Diamond Mines in Shaft No. 2, this interval measures about 43 feet, and in a boring in the Diamond Mine-drift 47 feet; but in an old boring near the Bellevue Mines, where the measures appear to be very different, the interval amounts to nearly 97 feet, the materials, so far as we can rely upon the indications of the chisel, consisting of sandstones in the upper half, and for the most part of slate and shale in the lower.

Coal G (or the Seventh Coal) rests upon shale, and is sometimes overlaid by slate, and sometimes by micaceous sandstone. Like most coals which consist of two or three or more benches, it is somewhat inconstant in its thickness, varying from 6 feet as a minimum to 10 feet or more as a maximum, counting the included layers of slate. It appears to possess an average workable thickness of 6 feet on the N.W. side of the river. Its total thickness at the Diamond Mine-shaft is 9 feet 5 inches, of which 7 feet 4 inches represent good coal. Its subdivisions will be given presently.

Between the last-named coal and the next, designated as H by us, though at Scranton it is usually called the "Diamond Coal," from the brightness of the lustre of one of its large benches, there is usually interposed a body of slate and sandstone, apparently of quite variable dimensions. At the Diamond Shaft the whole interval seems to amount to no more than about 10 feet, which is occupied by a sandy slate; but in the boring from the Diamond Mine-drift the space is reported to be 43½ feet, its lower half being filled by sandy slate, and its upper half

by sandstone. In the ravine near the Bellevue Mine, the space there separating the two coals, considered as the equivalents of G and H, measures by estimation about 35 feet. We are disposed to attribute the narrowness of the space between these coals at the shaft to a dislocation of the strata, of which there are some evidences in the ravine near by.

In the boring at the Diamond Drift, a coal, one foot thick, seems to have been cut midway between G and H.

Coal H.—The Diamond Seam reposes on a thick bed of clay-shale, or impure fireclay, containing rootlets of Stigmaria, and covered by a roof of a more sandy variety of the same rock, filled with beautifully-preserved ferns and other fossils. This bed of coal is sometimes called the "Ten-feet Seam." Like most of the others, it is a compound bed, though its principal bench, the uppermost, is generally a very thick one. In Shaft No. 2, the whole bed measures 12 feet 3 inches, and contains nearly 11 feet of coal. In a boring near the Vanstork Mines it indicates a thickness of more than 11 feet. In the Washburn Mine the whole thickness is 9 feet 9 inches, one foot of this being slate; and in the Fellows Mine, if our identification is correct, its whole size is only 7 feet. It would thus appear to decline in thickness as we trace it from N. to S., a view which is confirmed by the fact that the coal in the ravine on the Griffin Farm, regarded as the Diamond Seam, measures only 6½ feet, embracing 4 feet of coal.

Between Coal H, or the Diamond Seam, and the next higher one, sometimes called the "Seven-feet Bed," there is usually an interval of from 60 to 100 feet. This is occupied chiefly by sandy slates and argillaceous sandstones, with some beds of genuine quartzose sandstone. Near the central portion of the interval occur one or more layers of ball iron-ore, or nodular argillaceous carbonate of iron, imbedded in soft shale or fireclay. These layers have been met with in Shaft No. 2, and also in a boring near the same shaft; again in a boring on Washburn's land, S. of Keyser's Creek, near where the Hyde Park Company are operating; and in a boring near the Vanstork Mines, W. of Providence. Other layers of the ball iron-ore occasionally appear in the black slate which next overlies Coal H, as may be seen in Shaft No. 2. At the Diamond Mines the whole interval measures about 100 feet; on the fuller lands, much further N., the space amounts to no more than 66 feet, and it is considerably less than 3 feet in the ravine of the Griffin Farm, if we are correct in our identification of the coals there.

Coal I.—This coal, next above the Diamond bed, formerly known as the "Seven-feet Seam," and wrought a few years ago in some drifts above the Diamond Mine, is not at present mined in the vicinity of Scranton. The size of the bed can be best estimated from exposures in the ravine near Lewis and Howell's Slope-mine. At these openings it exhibits a thickness of 5 feet in two benches, displaying coal of good quality.

Succeeding Coal I, and separating it from the overlying seam, which we have called K, formerly known as the "Five-feet Seam," we meet with a stratum of soft ferruginous shale, and in some localities shale and sandstone. Along the S. face of the table-land, on which is seated the village of Hyde Park, the two coals range close together, the interval amounting to no more than about 20 feet. Further Southward on the Griffin Farm, the space between Coals I and K is very much greater—so much so as to justify some doubts as to the correctness of our identification, but it must be borne in mind that, as the upper coals of the basin are much less continuous than the lower ones, from being restricted to the higher hills and table-lands, between which wide spaces of the measures have been cut away, they are much less easily identi-

fied from point to point; and in their present undeveloped condition, mining operations having not yet extended to them, their relationships remain very obscure.

Coal K.—This bed of coal, best developed in the ravine near Lewis and Howell's Mine and along the Hyde Park Bluff, has a thickness of about 4½ feet. It is not at present mined near Scranton, but may at a future day prove valuable in localities where it possesses sufficient covering.

Coal L.—At an interval of about 12 feet above the Coal-bed K is a thinner seam, which at the above-mentioned ravine and in Hyde Park Bluff measures 1½ feet in thickness. At the head of the Griffin Ravine, near the Pittston Turnpike, the bed, which we have regarded as the equivalent of this, measures as much as 5 feet of good coal in two benches, being thicker than Coal K, from which it is separated by about 27 feet of blue slate, this underlying coal being at this locality scarcely 3 feet in thickness.

Along the Hyde Park Bluff, the interval of 12 feet between Coals K and L consists in the lower 5 feet of soft clay-shale, and in the upper 7 of blue sandy shale and slate, sometimes running into fireclay, with balls of rather coarse nodular iron-ore.

UNDULATIONS OF THE STRATA IN THE SCRANTON DISTRICT OF THE LACKAWANNA COAL-BASIN, AND THE DISTRIBUTION OF THE SEVERAL COAL-SEAMS IN THEIR LOCAL BASINS.

The several flexures which gently undulate the coal-beds of the district around Scranton, and which exercise a controlling influence on the distribution of the coal-seams, and the mining operations connected with them, are ten in number. We shall begin our description with the most Southern. Only the most prominent are inserted on the Map.

Anticlinal Axis No. 1.—The first notable axis lifting the rocks in the Southern part of the field near Scranton, is one which may be traceable from the stone quarry on the S. side of Roaring Brook, in a direction S. 70° W. across Stafford Meadow Brook, and finally across the back road to Pittston, where it is marked by a decidedly S. dip, at a point about half a mile W. of that stream. It appears to prolong itself as a very gentle undulation to the lower Swetland Coal-openings. Throughout its course the wave is very flat.

The coals lifted to the surface along this saddle or arch are evidently the lowest in the whole series—indeed, at Roaring Brook it is in the conglomerate, and outside of the coal altogether; but, proceeding Westward, it enters the areas of Coals A and B, and perhaps C, making a very shallow sloping basin of these with the Northerly-dipping strata of the conglomerate, which stretch Southward over the slanting plateau towards Stafford Meadow. A little to the S. of this anticlinal, two coal-beds have been opened in the basin in question, in the ravine of a little stream near the Smith Tract. The opening nearest the axis displays a bed 9 feet thick, dipping S. 2°; the other opening, further to the S., shows a coal 5 feet thick, dipping in the opposite direction, or Northward. Whether these belong to the same coal has not been ascertained, but they evidently embrace between them the middle of a shallow basin.

About 800 feet to the S. of the anticlinal, here called Axis No. 1, there are indications of another gentle wave ranging parallel with it to the back road. It may to some extent affect the mining at the collieries recently established near the township line. Both this and the main axis, No. 1, evidently rise towards the E.

Anticlinal Axis No. 2.—This, the first really conspicuous flexure of the district, is a long and very important one. It commences in the Dunmore Ridge, of which it is the most conspicuous undulation, being there discernible in very gentle S. dips in the hill S. of the village, between it and the mines. It is thought to cross the Drinker Turnpike about 1000 feet S. of the Lackawanna Railroad crossing. We detect it again on the South road leading from the mines to the main Scranton Road, from which point we may trace it to the Odd Fellows' Hall at Scranton, the axis following the West-sinking crest of the ridge. Two or three subordinate gentle undulations occur on the flanks of this wave between Dunmore and Scranton. This anticlinal is strikingly exhibited in the lower ridge of the Odd Fellows' Hall, where its S. dips are quite gentle, not exceeding 5° or 8°, whilst its N. ones are at 45° or even 60°, making the steep rocky bluff bordering Bank Street of the borough of Scranton. Traced Westward, it pursues a remarkably straight course about S. 75° W. to the Lackawanna, the flat ground of which it crosses S. of the covered bridge, entering the bluff bank overlooking the river at the mouth of Roaring Brook. It next displays itself in the cutting on the Lackawanna and Bloomsburg Railroad, N.E. of the Bellevue Mines. In the S. dips in this cut there are some indications of a downthrow, by which the very obliquely-bedded sandstones of the centre of the arch appear to be replaced by arenaceous slates. The plane of the fault dips Eastward at an angle of 70°, but its extent has not been determined. Pursuing the anticlinal axis Westward, it becomes more obscure, partly on account of its growing flatter, partly because of the obliquity in the bedding of the strata making the direction of the true dip uncertain. Expanding into an extremely gentle N. and S. dip, it ranges through the high ground which supports Mr Sherrard's house, and passes into the high table-land between the Lackawanna River and the valley of Keyser's Creek.

In this comparatively long range the flexure is arched by all the coal-seams in succession, from the very lowest of the series in the Dunmore Hill to the highest occupying the table-land N. of the Lackawanna. The details will be presented after the several anticlinal waves have been traced.

Anticlinal Axis No. 3.—The third flexure of the group is nowhere very distinctly exposed in any surface developments, but it is met with in the Pinebrook Mines, Nos. 2 and 3, where the coal is very gently arched by it, and the gangways of the mines are in consequence inflected. The crest of the arch passes near the air-shaft of Dip No. 3, or that of the slope. Westward of this its existence seems to be proved by a slight flexure of the coal in the old gangway of Washburn's Mine, but nowhere else has it been detected as a distinct roll.

Anticlinal Axis No. 4.—A far more important anticlinal wave lies a few hundred feet to the N. of the preceding one, pursuing a direction very nearly parallel with it and those previously described. It is displayed in the sandbank drift, or No. 1 of the Pinebrook Mines, where it shows both its N. and S. dips. It has not been discovered Eastward, but Westward its next distinct exposure is in the low broad arch at the Lackawanna River, near Washburn's Mine, where a coal, which appears to be the Diamond Seam, is lifted by it to the surface. From the circumstance that it lifts Coal F, or the Big Seam, high above the river-level at the Pinebrook Mine, while at the bend of the river at Washburn's it barely brings above the water-level Coal H on the back of the arch, it is obvious that this axis declines at a sensible rate to the Westward. Therefore it is, that, entering the high ground W. of the river, it is saddled by the upper coals of the series. The cuttings of the Bloomsburg Railroad have exposed this arch to view in a succession of

obliquely-bedded coarse micaceous sandstones of the ordinary type. On the Pittston Turnpike it is not distinctly indicated except in a few rather variable flat dips. If prolonged thus far, it would pass through the high lands in the central part of the Griffin Farm.

Its position Eastward seems to be indicated in one of the swells of the ground on the N. brow of the Dunmore Hill.

Anticlinal Axis No. 5.—At a distance of some 1500 feet N. of the preceding axis, there exists another anticlinal of some importance, the first which as far E. as Scranton lies altogether N. of the river. Owing to the general covering of diluvium in the immediate valley of the Lackawanna, this flexure does not show itself at the surface until it enters the hill just N. of the river, where the Fellows' drift-mine is situated in the Diamond Coal. There it elevates both coals G and H above the water-level, throwing them into N. and S. dips. Thence it is traceable Westward under the escarpment of the table-land occupied by the village of Hyde Park. Under this bluff it imparts to the coals K and L, which are there opened, a perceptible N. dip. On Washburn's Land the flexure may be detected in a little ravine, where it brings Coal K, and the small seam above it, Coal L, to the surface near the drift formerly called Phillip's. From this point it probably ranges near Fellows' Corner, and seems to cause the N. dip in the sandstones which are slightly exposed near the lime-tree standing in the cross-road which forms the E. boundary of the Griffin Farm from the Pittston Turnpike to Keyser's Creek, near Courson's Hampdon Mines. Beyond this spot all certain indications of it are lost, but its course is sufficiently well determined to enable us to affirm that it will traverse the N. slope of the high ground through the Griffin and the neighbouring farms. This flexure evidently sinks gently Westward, and dies away in that direction, but at a less perceptible inclination than some of those previously traced.

Anticlinal Axes Nos. 6, 7, *and* 8.—We come now to a group of three small undulations which occupy the general basin of the Diamond Coal. The first or Southern of these, No. 6, makes its appearance a few hundred feet S. of Lewis and Howell's Slope, on the railroad, in a confusion of dips, the prevailing ones indicating a flat arch. It has nowhere been observed except at this point, where it affected the progress of the old Swetland Mine by causing N. dips.

Of the two other undulations, one is visible in the bed of the ravine near the slope above mentioned, where it barely inflects the strata; the other exhibits itself as a slight undulation of the coal in the Diamond Mines. These two latter flexures, like the first named, have hitherto been seen only at the points now referred to.

Anticlinal Axis No. 9.—In the progress of mining in the Diamond Drift, a roll or abrupt undulation was met with, which for some time arrested its extension. This was a rather sudden turn in the dip of the coals, which altered its prevailing Southern inclination of 5° or less into a comparatively steep N. one of 15° or 20°. Though called a "fault" by the miners, it is really not such, but simply a saddling of the coal underground. The coal has been worked down the N. dip. The course of the anticlinal axis appears to be about S. 70° W. This takes it through a point a few feet N. of the air-stack in the field to the W. of the turnpike road. Westward of this spot, surface indications of its presence are wanting, and mining has not brought it to light.

Anticlinal Axis No. 10 (?)—Of the structure of the coal-field N. of the last-described axis of

the Diamond Mines, very little is at present known, nor is much definitely ascertainable until the mining is more extensively prosecuted in that quarter. There are, however, indications of a saddle in one of the cuttings of the railroad, which, if prolonged, would range about 1000 feet N. of the flexure last described. The topographical features of the ground appear to sustain this view, being such as a broad roll would impress.

The character of the ground, from the parallel of the last-mentioned axes to Keyser's Creek, is such as to obscure every indication of its structural features, and on the N. side of the stream the plain is deeply covered with drift as far as the rising slope of the mountain, which effectually obscures the coal strata.

We have no evidence of any anticlinal rolls on the flank of the mountain, though they will doubtless be discovered in the progress of research.

The conglomerate on the N. side of the valley, though in many places it exists only in detached masses, is elsewhere visible in conspicuous ledges. Its position is generally within the township line, a variable distance of from 500 to 1000 feet. The limit of the productive coal-field will probably be as much as 2000 feet within the line. As the conglomerate approaches Legget's Gap, it forms a separate inner ridge to the main mountain, and dips rapidly down into the gap. One or two unimportant beds of coal have been cut closely over it in the gap near the railroad.

Positions and Distribution of the several Coal-seams.—In explaining the positions occupied by the several beds of coal, and tracing them as they are distributed around Scranton, it will be convenient to indicate them first as they are lifted to the surface in succession along the several anticlinals, and secondly, as they outcrop one above another in the troughs or basins embraced between those saddles. Observing the order previously adopted in tracing the anticlinals themselves, we will commence with the coals brought to view along the crest of the first principal flexure—namely, Axis No. 2, or that which ranges from the Dunmore Hill, through the ridge of the Odd Fellows' Hall. It has been already intimated that the three lowest coals of the series, or Coals A, B, and C, lie high on both slopes of the Dunmore Hill ; and it may be added, that to the E. of the village A must spread itself over a considerable area on the very flat rising back of this broad elevated saddle. Descending W., these coals wrap round the base of the hill with a curving outcrop, changing their dips from N.W. to S.W. as they sweep round to take their places, one above the other, in the basin of Roaring Brook, at Plane No. 6 of the Pennsylvania Company's Railroad. In ranging through the ridge of the Odd Fellows' Hall, this gradually subsiding saddle just permits the Coal D to arch over it near the Hall with a gentle S. and a steep N. dip. Further W., at the junction of Roaring Brook with the Lackawanna, the strata which it brings to the surface are the higher ones, apparently those between the Big Coal F and that we have called G. It is probable that the Coal G, to the W. of this angle of the river, unites its two outcrops as the ground rises and the axis sinks ; and that to the W. of the mining village, the drift there opening a coal having a very gentle S. dip, belongs to the still higher Coal L, or that which is exposed near the head of the Griffin Ravine, close to the Pittston Turnpike Road.

Coals in the Basin South of Axis No. 2.—Sketching the coals in the basin S. of the second main axis, we find in the Southern escarped face of the Dunmore Ridge at Spencer's Mines (worked by Stevenson), four coal-beds above the conglomerate. Of these the third coal, C, of our enumera-

tion is successfully mined. The centre of the basin is thought to be about 150 feet N. of the mine mouth, the lowest of all outcrops a few feet below the level of Roaring Brook, near the foot of Plane No. 6. A mile and a half to the W., the second of these beds, or Coal B, crosses the gorge of the stream a few hundred feet S. of the Rolling Mills with a slightly N. dip. The two next higher principal seams, D and F, or the Big Coal, basin near the Furnace Dam, their S. outcrops passing the stream below the Rolling Mills, and their N. ones just rising to Anticlinal Axis No. 2, near the Odd Fellows' Hall. They basin out to the E. several hundred yards above the Furnace Dam. Below the Grist Mill, Coal G, sometimes called the Six-feet Bed, shows its S. outcrop near the back road, on the edge of South Scranton, or the working people's village. This coal, as already intimated, has its N. outcrop in this basin, a little S. of the junction of Roaring Brook with the Lackawanna. On the W. or rather the N.W. side of the last-named stream, we meet in this basin with all the coals from D, E, and F, near the margin of the river, to Coal L at the Griffin Ravine. Of the distribution of these, some details will presently be given.

The Southern limit of the subordinate coal-basin which we have now been tracing, is well defined by the outcropping of the massive beds of the underlying conglomerate whose pebbles are of nut and even egg size. This rock flanks the mountain at Plane No. 7, also on the S. side of Roaring Brook, opposite Spencer's Mines. It forms precipitate ledges at the falls of Roaring Brook, and extends along that stream to where it turns to flow N.W. Thence it sheets the flank of the mountain, along which run the two tracks of the Pennsylvania Coal Company, and it displays itself upon the rocky bluff faces of the mountain on both sides of Stafford Meadow Brook, following which it sweeps round to occupy the back valley of the Ore Mines. There is an inner ridge between the deep gorge of Roaring Brook and that of Stafford Meadow. The S. side of this is steeply escarped, as shown in our profile Section. The high watershed above this steep slope is capped by the coarse grey and somewhat pebbly sandstone which underlies Coal B or the Four-feet Seam. Under the ledge formed by this hard rock we may trace the thin seam A, and the thin upper layer which accompanies it, and may detect the Stigmaria shale which invariably attends them.

Coal B in Roaring Brook Basin.—From the point at which this bed is worked near Plane No. 6, its outcrop ranges along the slope of the hill which overlooks from the N. side the valley of Roaring Brook. It holds its assigned place under one or two conspicuous ledges of solid sandstone. Sweeping gradually round in a line approximately parallel to the stream, it crosses the railroad in the first cut above the Rolling Mill, where it is finely exposed. From this place it dips to the Rolling Mill-dam, immediately below which, at the end of the mill, a tunnel is driven to cut the coal. On the opposite side of the stream, the coal, rising from the water-level at an inclination of about 10°, is entered by a drift, now furnishing coal to the furnaces. From this point the outcrop of this bed, traced W., lies high on the inner ridge, running nearly parallel to its escarped face. It then gradually deflects more rapidly W. to the valley of Stafford Meadow Brook, beyond which its outcrop has not been followed. This coal is not known to outcrop anywhere else, except as here described, in the Scranton district, until, on the opposite side of the general basin, it rises to the surface again high on the slope of the mountain bounding the valley on the N.W.

As this Coal B presents itself in the mine on the S.W. side of Roaring Brook, it consists, as

already said, of a bottom bench 3 feet 2 inches thick; over this a layer of slate 2 inches, and above this 14 inches more of a roughish coal. At Plane No. 6 it measures between 5 and 6 feet. Its productive thickness is about 4 feet.

Fig. 264.—Coal B, Roaring Brook.

Coal D, in Roaring Brook Basin.—The next workable seam in this first subordinate basin, or that of Roaring Brook, makes its appearance near the falls of Roaring Brook in an outcrop about 1500 feet N.W. of the N.W. crop of Coal B last traced. Following this W., it curves gently N., to take a position in the ravine where an opening on Mr Sanderson's land was designed to enter it. Beyond this point it pursues a direction almost due W., and skirting the Southerly face of the hill on which Mr Selden Scranton's house is situated, it dips at a gentle angle to the Furnace Dam, where two drifts enter it at different levels, penetrating far under the hill. On the S. side of the brook it is not mined, but its outcrop can be traced in an almost straight line towards Mr Slocum's house near Stafford Meadow Brook. This is doubtless the same seam which is exposed at the river bank a little beyond the Bellevue Mines. It is represented in our Section of the coals at that point where it is shown to be subdivided by bands of slate. In the inner workings of the drifts on Roaring Brook, this coal is squeezed out by the approach of the upper and lower rocks. Its dimensions, where this thinning-away in the upper level commences, are as follow :—

	Feet.	Inches.
Coal,	4	6
Slate,	0	5
Bony coal,	0	9
Coal, good,	1	0

Fig. 265.—Coal D, Scranton, near the Rolling Mills.

About 50 feet further forward the upper bed thins down to 2 feet, and is gradually lost. How far this pinch continues was not ascertained at the date of our last examination (1856). The so-called "Four-feet Seam" overlying it, varying from 1 to 6 feet in thickness, is in many places worked in the same mine with this.

Coal E, Roaring Brook Basin.—Nothing additional to what has been already stated respecting this thin seam need be here given, further than to call attention to the fact that this coal, if it ranges to the bluff back of the Lackawanna W. of the Griffin Farm, is there most probably either a lower bench of the Big Coal E, or an upper division of the next main lower bed D.

Coal F, Roaring Brook Basin.—The large seam, Coal F, has been more exposed to removal by excavating floods than either of those previously described, simply from its higher position in the series. It is evidently wanting in the high ground near the village of Dunmore, nor have we any evidence of its presence until we approach the flats on the road leading from Dunmore to Providence. It would seem to have escaped denudation on the S. side of the saddle of the Odd Fellows' Hall (Axis No. 2) all the way W. from a point a little E. of Mr Joseph Scranton's residence. Followed E. from this spot, its outcrop passes a little S. of Mr Mati's house. Before reaching the Falls Road, it swings round to run parallel with it for about 100 yards, and there deflects rapidly to take the brow of the hill, along which it ranges parallel to Coal D, until it is cut by the valley of Roaring Brook; then it swings with the stream toward the furnaces, in digging the foundations for which it has been cut near the creek-level. It thus appears that the hill supporting Mr Selden Scranton's house occupies nearly the centre of the basin of this coal-bed. This valuable seam, in consequence of its very gentle dip, presents a long line of frontage

to the stream opposite the furnaces, where, for several years past, it has been mined. Traced W., its outcrop may be seen from the character of the surface to approach that of Coal D, but it soon becomes obscured by a deep covering of diluvium. Further W. in this basin, the Big Coal ranges under the flats of the Lackawanna until it emerges once again to view at the foot of the river bluff. There it gives indication of a feeble undulation in an old drift, but this flexure is nowhere discoverable further E.

OF THE ROARING BROOK BASIN WEST OF THE LACKAWANNA.

Crossing now the Lackawanna, and studying the strata, with their coal-beds, as they are developed by surface-proving and mining on the Griffin Farm and mines adjoining, between that stream and the Pittston Road, we find the ground to contain, in the line of the Roaring Brook Basin, the whole succession of the coal series of the district, from Coal D at the edge of the river to Coal K, near the head of the ravine at the road. This sequence of the coal-beds, with their included strata of shales, slates, and sandstones, is represented in a profile Section under their true dips and relative thickness.

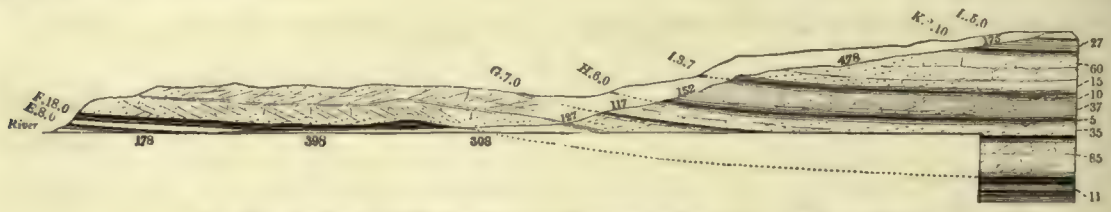


FIG. 266.—Section of Griffin Ravine W. of Scranton, looking N.E.—1 *inch* = 400 *feet*.

This Section spans two-thirds of the breadth of the Roaring Brook Basin, the other third extending from the Lackawanna to the anticlinal axis No. 1, or that which lifts one of the lower coal-seams to view a little S. of the back road to Pittston. It will be observed, however, from the Section, that there prevails but one direction of dip in the strata across this broad space. This is in consequence of the flattening down of the second anticlinal, the arching of which is barely noticeable at the mouth of Roaring Brook, and becomes almost or altogether null as far W. as the main road, its sole effect there being to lift the strata into a horizontal position, not to incline them S. The coals do not lie, therefore, strictly in basin form, but only on the S. side of a very broad flat basin, the one margin of which is the S. Axis No. 1, the middle of which is the high table-land between the Lackawanna and Keyser's Creek, gently undulated perhaps by one or two of the anticlinals of the Lackawanna; and the N. side of which is formed by the South-dipping strata of Keyser's Creek on the mountain N. of it. As already intimated, only the lower coals have their outcrops S. of the Lackawanna opposite the Bellevue Mines, but as we go further S.W., near the township line, coals even as high as the Diamond Seam appear to come in. On the lands of the several companies entitled the National, the Quaker City, and the Anthracite, collieries have been recently established on one or other of these coals, but particularly on coals D and F. At Taylorsville, upon the Union Coal Company's property, extensive shaft-mines have been commenced upon coals thought to be D, F, and G. In the bluff which ranges from the river on its N. side to the mouth of the Griffin Ravine, coals D, E, and F appear, and it is obvious, from the direction of their dip and the form of the ground, that their outcrops, under the alluvial flat below the Bellevue Mines, must, from the depth to which the coal strata have been there washed

away, lie considerably to the N.W. of the lines prolonged from their outcrops at the foot of the bluff; in other words, a deep denudation has swung their outcrops Northward.

Following this bluff, and afterwards the Griffin Ravine, into which it prolongs itself, we meet with the several coals in succession thus: First, close to the river edge, at the base of the hill, appears *Coal D*, dipping very gently Northward from the stream. Its face has been well stripped to show its quality, size, and subdivisions, which are as follow:—

	Feet.	In.		Feet.	In.
Coal, very good,	4	0	Slate,	1	0
Coal, bony,	0	11	Coal, good,	1	8
Slate,	0	8	Slate,	3	6
Coal,	1	0	Coal,	1	4

Coal E of Roaring Brook has, at this more Western locality, either thinned down and disappeared altogether, or it has merged itself into Coal F as a lower bench, by the thinning-out of its few feet of overlying fireclay, the most probable view of the two.

Coal F.—Regarding the second thick mass of coal as one seam, though made up of several benches, and viewing it as the equivalent of the Big Seam of Roaring Brook, we find it developed in usual magnitude in the bluff at the river. Its dip is extremely gentle Northward, and several drifts and provings give ample opportunity for estimating its size and subdivisions; these are as follow:—

	Feet	In.		Feet.	In.
Coal,	1	0	Slate,	0	6
Slate,	0	6	Coal,	0	7
Coal, bony,	1	3	Slate,	0	2
Coal,	5	0	Coal,	2	4
Coal, bony,	0	4	Slate,	0	6
Slate,	1	6	Coal,	2	9
Coal,	2	0			

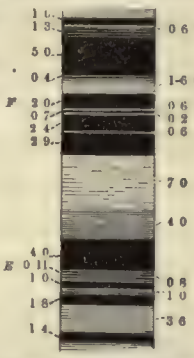


FIG. 267.—Coals F (Big) and E, River Bluff, near the Bellevue Mines.

This coal vanishes under the flats a few hundred feet S. of the mouth of the Griffin Ravine, and must outcrop in the flats S. of the Bellevue Mines.

The next seam ascending is *Coal G.* This enters the ground above the water-level of the Griffin Ravine immediately N.W. of the Lackawanna and Bloomsbury Railroad; its outcrop curving Eastward out of the ravine, and thence N.E., passing S. of the slope, and N. of the Shaft No. 1 of the Bellevue mines. The coal having been washed away at the point where the shaft is sunk, the coal-bed first to be met with in this shaft will be the Big Seam. The depth reached in January 1856 was 120 feet, making it probable that the large coal would soon be struck. This coal-bed of the slope, or G, exhibits at this locality—

	Feet.	Inches.
Coal,	2	6
Slate,	0	2—4
Coal,	3	6

The slope does not enter directly upon the coal, but reaches it through overlying material at a moderate depth, by descending at a steeper angle.

The coal next above that entered by the slopes is also exposed in the Griffin Ravine west of the Bellevue Mines, where its outcrop is about 35 feet above the slope-bed. In geological posi-

tion it corresponds to the Diamond Seam, though at this locality it fails to sustain the usually high reputation of that coal. It contains between top and bottom slates a thickness of 6½ feet, though at this point the good coal amounts to only 4 feet. It seems to underlie the high ground back to Keyser's Creek, near which stream, at the Hampton Mines, a shaft has been sunk, meeting what appears to be this coal at a depth of 121 feet beneath the surface. The seam there struck possesses the usual dimensions and good quality of the Diamond bed. At that shaft the following measurement of the coal was obtained :—

	Feet.	In.		Feet.	In.
Coal, . . .	5	9	Slate, . . .	1	10
Coal, bony, . . .	1	3	Coal, . . .	1	8
Coal, fair quality, . .	1	10	Fireclay, . . .	...	

The dip is 2° S., from 10° to 15° E.

A little East of the Hampton Mines, the Hyde Park Coal Company propose working the same bed by a shaft, which it is estimated will require to be sunk about 115 or 120 feet from the surface.

In the Griffin Ravine, as shown upon the Section, the next overlying coal-seam lies about 52 feet higher than the previous one, though, from some dislocation or slip near the Bellevue Slope, the interval which there separates them is only a few feet. Where visible, this coal has a thickness of about 3½ feet.

The next ascending, considered to be Coal K, is separated from that last mentioned by as much as 80 feet of argillaceous sandstone in the Griffin Ravine. It is about 3 feet thick.

The highest coal, L, here discovered displays, in a trial-shaft made at the head of the ravine near the turnpike, a thickness of 5 feet of good coal. It evidently is to be found only in the higher ground. This upper coal is that formerly opened on the old road leading to Landis's house on the turnpike. At this point the dip is 2° S., showing it to be on the N. side of the basin. It is supposed to be the same coal which is worked in the depression further towards Hyde Park known as Philips' bed.

On the top of the saddle, No. 2, exposed in the cut Eastward from the Bellevue Mines, the seams above Coal G appear to be denuded away, to enter again under the higher ground further W. In this cut of the railroad a boring is reported to have met with the following results : Rock, 16 feet ; slate, 1 foot 4 inches ; coal, 7 feet 8 inches, divided by 7 inches slate ; slate feet to rock. The coal here cut is deemed to be the slope-coal G. Along the top of the cut, black dirt is visible, and the same was cut in several wells. This may be "washing" from the Diamond seam.

Coals on Axis No. 4.—It has been already intimated that the anticlinal axis or saddle No. 4 elevates the Big Coal F to a considerable height above the Lackawanna, in the Pinebrook Mines, without lifting it out to the surface. Between the water-level workings of this mine, and the bend of the Lackawanna River below the bridge uniting Scranton with Hyde Park, Coal G must somewhere span this saddle, dipping Northward into the synclinal basin occupied by the river, and Southward into the narrower and flatter basin contained between this and Axis No. 3. It is probable that the N. and S. outcrops of Coal G meet on the back of the saddle somewhere near the Freight Depot, though they are entirely concealed by drift. The next coal which arches the

axis is that of Washburn's Mine at the bend of the Lackawanna, which, there is every reason to believe, is the Diamond Seam, or Coal H. Of course, if the anticlinal continues gradually to sink and flatten in proceeding Westward, the mining in this seam cannot be carried far in that direction before the coal will lap across the axis and sink to the water-level. Ascending towards the main road along the line of this axis, we find it nearly spanned by one of the upper coals, apparently K, or the so-called "Five-feet Seam," at this road between the old Philips Drift and the Griffin Farmhouse. Beyond this vicinity the axis and the coals upon it cannot be traced.

COALS IN THE SCRANTON BASIN, OR THAT BETWEEN AXIS NO. 2 AND AXIS NO. 4.

The most accessible or highest workable coal embraced between the limits of the Odd Fellows' Hall anticlinal and that of the Washburn Arch, is the Big Seam, or Coal F. The mine-galleries or gangways in this coal enable us to trace its outcrop with considerable precision. Commencing with the S. brow of the hill N.E. of the Rolling Mill, overlooking the depression in which Coal D is opened, the outcrop of the Big Seam is traceable Westward to the Falls Road, which it barely crosses, turning almost immediately N. to run parallel to the road, which it presently recrosses to saddle the anticlinal axis of Dunmore and the Odd Fellows' Hall, passing under Mr Hitchcock's barn. On entering the main Scranton Basin it crosses the Dunmore and Scranton Road at right angles, a little E. of where the Falls Road turns off. The outcrop now swings away towards the centre of the town, and is no longer traceable. The subordinate anticlinal, No. 3 of the series, which passes through the centre of the town, throws out the Big Seam to the surface S.E. of Pinebrook, and the coal is exposed in two lines of outcrop which converge Westward, and unite across the saddle near the air-shaft connected with Drift No. 3. The Southern outcrop connected with this saddle crosses Olive Street of Scranton almost at right angles, then bends and runs parallel to it, and finally sweeps round and becomes parallel to its first course, when it again turns and crosses Madison Avenue. The Northern line of outcrop pursues a nearly Easterly course from their point of divergence over the axis. Drift No. 3 enters by a slope until it strikes the coal dipping N., then swings round Southward over the saddle, meeting Drift No. 2, which enters nearly S. of the saddle further Eastward, being driven to meet the coal on its S. dip. It was stated that the other axis next N., or No. 4, does not lift the Big Seam to the surface, but is surmounted by the gangways in the Pinebrook Mine No. 1. A deep covering of diluvium hides all the strata between the Pinebrook Mines and the river at Washburn's Mine. Even the wells, sunk in the sand and gravel to a depth of 70 feet, have failed to reach the Coal-measures.

The following are the subdivisions of the coal at the Pinebrook Mine No. 1. It may be taken as a type of the coal at the various openings, though there is some variation in the thicknesses :—

	Feet.	Inches.		Feet.	Inches.
Coal, impure,	1	0	to	1	3
Slate,		...	„	1	9
Coal, good (Foundry bench),	2	6	„	5	0
Coal, bony,	1	0	„	1	6
Slate,	0	6	„	2	0
Coal, good,	5	0	„	6	0

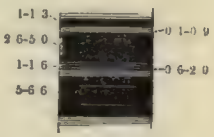


FIG. 268.—Big Coal F, Pinebrook Mines.

BASIN OF PINEBROOK AND THE LACKAWANNA.

The fifth anticlinal, ranging through the Swetland Meadows north of the Lackawanna, must cross the stream in the neighbourhood of the bridge of the plank road. A coal-bed, apparently not a very thick one, outcrops near the bridge. The probability is that this seam is identical with the lower one of the bluff at the Fellows' Mine—namely, Coal G. If such is the case, the basin of the Big Seam of Pinebrook can extend to but a limited distance Northward of the brook; how far up this stream it basins out, has not been ascertained. In consequence of the Westward declension of the two saddles bounding the basin, this trough of the coal itself subsides gently in the same direction. It follows as a physical necessity, that as we pursue it Westward, higher and higher coal-seams will come in, first G, and then H, and finally I and K. Now Coal H, or the Diamond Seam, evidently occupies about the middle of the trough at the river, from the railroad bridge up to the Fellows' Mine, for at this latter spot it rises to the N. bank of the river with a gentle Southward dip, while, a little way above the railroad-crossing, it sinks into the stream with a N. dip on the opposite bank. The actual termination Eastward of the narrow basin of this seam cannot therefore be far Eastward of the Fellows' Mine, and it must be somewhere between this point of the basining-out of the Diamond Seam, and the Pinebrook working of the Big Seam, that the next lower coal, G, must end in a similar spoon-shaped trough. Coal I, in all probability, basins out W. of the Lackawanna, near its bend below Hyde Park bridge, while K terminates its small upper trough on the Fellows' land, near the main road to Scranton.

BASIN OF THE DIAMOND COAL MINES.

We come now to consider the coals and their outcrops in the wide, flat, undulating basin N. of the fifth anticlinal. This, which is the main central basin of the district, is that which embraces the Diamond Mines east of the Swetland Meadows; very little is known of the coal-beds within the belt, but W. it contains all the higher coals of the district. It is needless here to recur to the details already furnished respecting the lesser anticlinal flexures between the main axis No. 5 and the most Northerly known, or No. 9, or to the coal-seams lifted by them to the surface along the Hyde Park Bluff. These flexures are prolonged Westward, but in the absence of mining or surface indications they cannot be traced. The central synclinal, or deeper middle line of the general trough, lies not far, probably about 200 feet, S. of Slope No. 2, and if prolonged so far, it must hold about the same position with reference to Coursen's Shaft at the Hampton Colliery on Keyser's Creek. At both of these localities the basin contains the Diamond Seam, and, as a consequence, all the underlying coals.

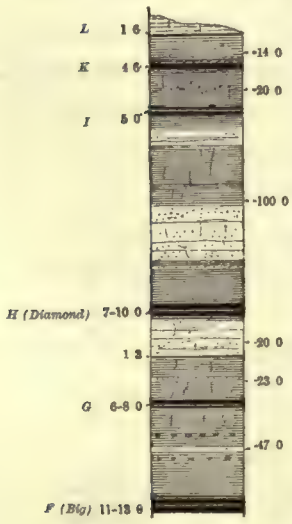


FIG. 269.—General Section, Diamond Mines.

Outcrops.—Commencing with the lower outcrops accessible along the bluff bordering the Swetland Meadows, we may trace them along its base, by the surface-workings of the Diamond

Mines, the whole way from a drift in the Diamond Seam, in a little ravine just W. from the plank road, S. past the Diamond Mines, and the mouth of the ravine at Lewis and Howell's, (known as Silkman's), and past the Old Swetland Drift, until we reach the foot of the little anticlinal ridge, where these two coals are lifted by the arching of anticlinal axis No. 5, and thrown out, to enter the ground again on the S. side of the axis at the Fellows' Mines. Along this bending line of outcrop, these two coals undulate gently over the three intervening anticlinals, Nos. 6, 7, and 8, which are so flat and gentle as to occasion almost no deflection of the gangways within the mines, their tendency being to hold up the coals, and spread them near the surface in a broad expanse, admirably adapted for economic mining. The Diamond Mine-drift enters this coal at the level of the Meadows. A boring here made cut Coal G at a depth of about 43 feet, and penetrated 47 feet lower to the Big Coal F. Adjoining this drift, Slope No. 1 descends obliquely through the measures, separating the Diamond bed from Coal G, to the latter seam. Slope No. 2, further S.W., descends through overlying materials to Coal H. Still further S.W., Shaft No. 2 enters the ground at the foot of the second bluff, and penetrates to the Diamond, or Coal H, at a depth of about 100 feet. From the bottom of this coal in the shaft, a boring has been carried down, cutting Coal G at 10 feet depth, and Coal F 43 feet below the bottom of Coal G. Our section of the shaft exhibits these coals.

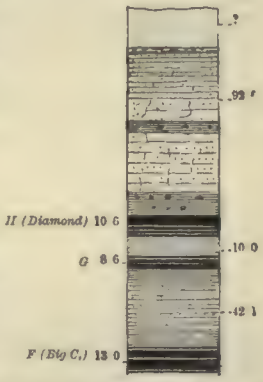


FIG. 270.—Shaft No. 2, Diamond Mines.

Proceeding next to the coal-beds I and K, we find them ranging parallel for many hundred yards along the line of the Northern division of the Delaware, Lackawanna, and Western Railroad, the cuttings of which expose them in some places clearly to view. The outcrop of Coal K is in some places above, in others below the railroad-level, while that of the underlying Coal I runs below the railroad, near the base of the upper bluff. From the Silkman Ravine the outcrop of Coal K may be traced along the face of the upper bluff, or that which immediately supports the village of Hyde Park, running at first S. and then S.W., until, crossing the Scranton and Hyde Park Road, it meets the fifth anticlinal axis. Here an extensive denudation of the strata, forming the S. flank of this very flat saddle, has cut away the South-dipping portion of the coal, and left it with one outcrop, to enter almost horizontally the face of the bluff.

A little W. of the Silkman Ravine, a colliery has been established in the Diamond Seam by Lewis and Howell, access to that coal being had by a slope-mine sunk Westward obliquely through the strata, commencing in the ground between the outcrops of Coals I and K, and cutting the Coal I in its descent to Coal H, in which it terminates.

N.W. of the line of outcrop last traced we are unable to discover any outrising of the coal that can be identified. A few surface-shafts have been sunk, but they lead to no positive results. We feel quite assured, however, that none of the lower coals rise to the surface in the high ground S. of Keyser's Creek; beyond this, however, they outcrop in succession on the flank of the mountain bordering the valley on the N.W.

The following measurements exhibit the thickness and subdivisions of the Diamond Seam, and Coals F and G, at the mines near Scranton.

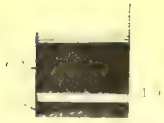


Fig. 271.—Coal H. Washburn Mine.

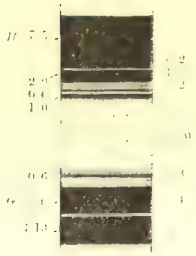


Fig. 272. — Coals H and G, Shaft No. 2, Diamond Mines.

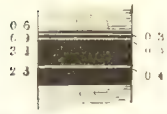


Fig. 273.—Coal G, near the Fellows' Mine.

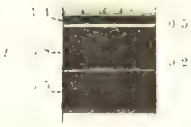


Fig. 274. — Coal F, Shaft No. 2, Diamond Mines.

	Feet.	Inches.
Coal H, or Diamond Bed, Washburn's Mine—		
Coal,	6	9
Slate,	1	0
Coal,	2	0
Coal H, Diamond Mine Shaft—		
Coal,	7	5
Slate,	0	2
Coal,	2	0
Slate,	1	0
Coal,	0	6
Slate,	0	2
Coal,	1	0
Coal G, near Fellows' Mine—		
Coal,	0	6
Slate,	0	3
Coal,	0	9
Slate,	0	3
Coal,	3	2
Slate,	0	4
Coal,	2–3	0
Coal F, Big Seam, Diamond Mine Shaft—		
Coal,	1	4
Slate,	0	5
Coal,	5	8
Slate,	0	2
Coal,	5	5

To bring out in a clearer light the remarkable productiveness of this portion of the lower Coal-measures of the Scranton district, I will present in a tabular form the actual least thicknesses of the several coals within the strata, their net thickness of good coal fit for market, and the computed yield of such coal per acre from each bed.

TABLE.

Coals.	Least Thicknesses.	Good Coal.	Yield of Good Coal per Acre.
K,	5 feet.	3 feet.	4,000 tons.
I,	7 „	$4\frac{1}{2}$ „	7,000 „
H,	10 „	$7\frac{1}{2}$ „	12,000 „
G,	6 „	3 „	5,000 „
F,	12 „	9 „	15,000 „
D,	8 „	6 „	10,000 „
C,	6 „	$4\frac{1}{2}$ „	7,000 „
	54 feet.	$37\frac{1}{2}$ feet.	60,000 tons.

These totals hold good, of course, only for those portions of the coal-field which are underlaid by all the seven coals enumerated. If we wish to aggregate the gross amount, the net amount, and the amount per acre, contained in the four middle beds D, F, G, and H, which lie

within a thickness of 200 feet of strata, and spread beneath every acre of the central coal-field, excepting only a narrow belt along its S. border, we shall find, on summing up the columns of the table, that the least total thickness of these coals is 36 feet, their yield in thickness of good coal is upwards of 25 feet, and their productiveness per acre 42,000 tons.

In the N.E. portion of the district under consideration, several collieries have been established within a few years, and are in successful operation. These are as follow :—

The Slope Mine of the *New York and Pennsylvania Coal Company*, situated upon Fuller's Creek, a tributary of Legget's Creek. In this mine the Big Coal is wrought, and displays the following dimensions :—

	Feet.	Inches.
Coal, poor,	3	0
Coal,	4	2
Slate and bone coal,	1	2
Coal,	4	8

The coal at this point is of inferior quality, and we learn the Company are about to tunnel Northward to Coal D, which in a drift displays a thickness of 6 feet free from slate. Between the two larger beds a 2-feet seam is displayed in the brook bed.

Clark's Mine.—At this point Coal D is wrought by a slope, sunk Northward to meet it upon a gentle Southward dip. There are one or two water-level gangways entering upon the same bed in the neighbourhood. The coal varies in thickness from 5 to 8 feet.

The *Luzerne Coal Company* have sunk a slope in the Big Seam upon the bank of Legget's Creek ; the dip is Southward. The coal possesses its average dimensions.

N.W. of the village of Providence the high ground evidently contains Coal I, and of course the Diamond bed and the seams beneath it. This has been proved by several borings, upon the basis of which the *Vanstork Coal Company* are about to establish a shaft-colliery. They are reported to have cut Coal I at 100 feet beneath the surface, below which Coal H has been found at the unusual depth of 150 feet. It is said to be 9 feet thick.

Subjoined are the results of a boring made on the flats of the Lackawanna opposite Providence ; how far they are reliable I am unable to say :—

	Feet.	In.		Feet.	In.
Surface material, sand, &c.,	54	3	*Coal,*	1	6
Coal,	6	0	Slate,	0	7
Slate,	3	0	*Coal,*	2	1
Sandstone, hard and white,	22	1	Fireclay, ball ore,	19	10
Slate,	1	0	Sandstone,	3	11
Sand-rock,	18	1	Slate, with ore,	25	7
Coal,	0	6	*Coal,*	6	1
Slate,	18	8	Slate,	0	2
Coal,	0	7	*Coal,*	1	4
Slate, &c.,	10	1	Slate,	6	10

ROAD BETWEEN HYDE PARK AND PITTSTON.

About a quarter of a mile W. of the Meeting-house, on the road (3½ miles from Hyde Park), strong N. dips were seen, followed by decided S. dips, then an undulation and S. dips again. Here seems to be a well-marked anti-

clinal, crossing the road obliquely. About 200 yards E. of Stewart's Lackawanna Tavern are exposures on the S. side of the road of sharp knobs of South-dipping massive sandstone, and near the road North-dipping rocks, forming a sharp anticlinal turn. On the first hill below this tavern the dips are N. and E. Near the blacksmith's shop, at the road fork, on line between Lackawanna and Pittston townships, a coal is opened, measuring about 7 feet. A little to the N., in a field, is a ledge; dipping N. is another seam geologically above that outcropping on the road.

On the farm of Erastus Smith, near the Northern Road, a road up the back valley on the N. side of the basin, a 7-feet coal has been proved. All the coal hereabout dips to S. rather gently. Smith's opening is situated on the S. side of the North Road near the sawmill. Babb has opened a coal on the flank of the mountain N. of his place, and the Big Bed of Pittston is thought by some to crop out on the mountain. Between the North and Main Road Philips has opened a 7-feet coal.

Above the Old Forge place Drake has opened a 7-feet coal in a hollow leading down to the diluvial plain, in a direction a little E. of S. from the barn at the *fault* or anticlinal seen on the middle or turnpike road. This opening seems to be about 800 feet from the road; the dip is gently N. Farther S., and quite near the N. bank of the Lackawanna, Drake has opened a 5-feet bed, and between this and the other has found proofs of still another coal. The coal of the 7-feet bed is used by the neighbours, and is said to be very good.

At the crossing of the Lackawanna, at Old Forge, there is a long series of exposures of sandstone with gentle N. dips. At Babylon the dip is flat Southward. Near this place a boring was made, near the middle of the river, to a depth of 76 feet, when the machinery was swept away by a freshet. A small coal, 4 inches thick, was cut 60 feet from the surface. A little below Babylon is Massey's Coal, dipping gently S.; it is 8 feet thick, and corresponds to the 7-feet bed at Pittston.

FROM SPRING BROOK TOWARDS SCRANTON, *VIA* THE SOUTH ROAD.

At the point of the first hill or cliff N. of Spring Brook, a sandstone dips very flat Northward from a point 200 yards from the house at the foot of the hill.

Due N. from the foot of the hill, a cliff on the N. side of the Lackawanna flats, about a quarter or a third of a mile distant, exhibits strata dipping gently Northward.

On the first bench of the hill, coarse pebbly sandstone dips 8° N. in a fold about 300 feet N. of the road. This is better seen in a N. dip and gentle roll on the top of the hill, where, though almost flat, its inclination is Northward. A little beyond is a local anticlinal.

The next hill-top displays very flat N. dips. Near the top of it Mr Tuttle has opened a coal 8 feet thick, dipping 5° N. Mr Tuttle says this coal enters the hill-top S. of this locality. He thinks the coal and Drake's on the opposite side of the river are the same. Thus far all the rocks have an average N. dip.

On the creek which crosses the road, the only one on the map, a little way below the road, coal is said to have been dug. Ascending for a considerable distance, and then proceeding, we have a wide flat surface, evidently of nearly horizontal rocks, though no masses are to be seen. Moore's coal-opening on this road displays—

	Feet.	Inches.
Coal,	1	6
Slate,	1	0
Coal,	5	0

In the ravine N. of J. D. Smith's, on the back road from Pittston, about 2½ miles from Scranton, there are two veins—the Coal A, at the head of the ravine, dipping N. about 12°; about 4½ feet have been opened, but it is said to be much thicker below: another, Coal B, is undulated, and displays two outcrops. Some 6½ feet of coal are exposed, but the bed is evidently thicker than this. The dip of slate and coal near the Lackawanna is very decidedly S. On the opposite side of the Lackawanna is Phelps' Mine, sold lately to the New York Company.

STRATA EXPOSED ON THE PENNSYLVANIA COMPANY'S LOADED TRACK RAILROAD FROM PITTSTON TOWARDS SCRANTON.

The top of Plane 2 at Pittston lifts us above the great lower terrace of drift. Here we have good exposures of Coal-measures dipping N. about 15°. A coal is opened to the S. of the track and 20 feet below it. The road keeps nearly on the strike for 2 miles, showing all along the same dip. This brings us opposite Plane 22 of the empty track to the S. On this empty track between Plane 22 and Pittston, the dips, approaching Pittston, are steady, and decidedly S. Between the two tracks there is therefore included an important anticlinal. Half-way up Plane 2 we have the level of a second terrace of drift. Between Planes 3 and 4 the dips seen are undulating, and those towards the N.E. end of the interval are mostly S., but very gentle.

Plane 4 is a superb cut in heavily-bedded sandstone. At the top are seen large faces of North-dipping sandstone, and this dip is repeated all the way to the foot of Plane 5. The road takes a more Southern turn after leaving Plane 4, and cuts into and through the North-dipping conglomerate.

We now move along through the great gorge or natural cut in which both tracks pass. We pass from the conglomerate Southward into the reddish sandstone and sandy shale below, and continue in these rocks a little below the conglomerate to the foot of Plane 5. The conglomerate crosses this plane about midway up, dipping N., and we continue on it to the neighbourhood of Plane 6.

IRON ORES OF THE VICINITY OF SCRANTON.

It has been already mentioned in an early part of this description of the basin, that the Umbral or Red-shale formation of the upper part of the valley of Stafford Meadow Brook, includes a layer or layers of a peculiar variety of iron ore, smelted at the Scranton furnaces.

This belt of ore is known to range for a mile or more with the outcrop of the strata enclosing it, but to the E. and W. of that space it either thins away or becomes too poor in oxide of iron to be recognisable or worth pursuing. Thus no traces of it are to be detected in the prolongation of its outcrop, either in the upper valley of Spring Brook, or in that of Roaring Brook at Cobb's Gap, and it seems to be restricted, or nearly so, to the lands of the Lackawanna Iron and Coal Company.

Its dip is *with* the strata, or towards the N., at an average angle of 15° or 20°, and its topographical position is the East and West-ranging longitudinal valley between the two mountain-ridges, that of the Seral conglomerate and Umbral sandstone on the N., and that of the Vespertine sandstone and conglomerate on the S. The geological situation of the ore is just above the upper layers of the latter formation, or among the lowest of the shales and fireclay beds of the Umbral series.

As exposed at the mines of the Lackawanna Iron and Coal Company on the Stafford Meadow Brook, the ore lies imbedded in a true fireclay or soft clay-shale, the average thickness of which is about 6 feet, while the ore for the most part is in two layers or courses, the lower one a continuous band some 18 inches thick, and the upper one a layer of flat balls or cakes 12 inches or less in vertical diameter. Beneath this ore-stratum is a buff-coloured and greenish sandy shale, and supporting it in turn, a grey compact sandstone, which I deem the upper bed of the

great Vespertine or Lowest Carboniferous Series. Above the ore-deposit reposes a bed of close-grained, grey, argillaceous, shaly sandstone, of an average thickness of 30 feet, and in the middle of this lies a band of fireclay one foot thick, containing also scattered balls of iron ore. Over this sandstone occurs a mass of 30 feet of yellow and red shale, more characteristic of the ordinary red shale outside of the coal-basins than any of the other subjacent members of this group of strata, which present, indeed, almost the maximum of deviation from the usual conditions of the Umbral formation. The stratum embracing the iron ore abounds in the same delicate fossil rootlets of the plant called Stigmaria, which are so distinctive of the fireclay beds which support the seams of coal.

Fig. 275.—Umbral Strata, showing position of Iron Ore, Stafford Meadow Brook. — 1 *inch* = 200 *feet*.

The iron ore itself appears to be a concretionary deposit, collected from the imbedding fireclay and overlying strata at their outcrop. The oxide and carbonate of iron of which it is composed, have been primarily diffused through these rocks, in part, perhaps, under the form of the sulphuret of iron, and subsequently gathered thus into sheets and layers of balls by infiltration of the rain and other surface-waters. In confirmation of this view of the origin of the ore, it appears that the deposit grows less rich in iron wherever it is followed far into the hill, or is covered with tight overlying strata, as to have experienced a less than ordinary share of percolation from the surface. In these positions the ore is little else than a fireclay, with a merely greater than usual impregnation of the oxide of iron.

The ore, as taken from near the outcrop of the beds, where it is extensively mined by shallow drifts and by stripping, is a mottled dark-green and red sub-crystalline mixture of the carbonates of iron and lime with the peroxide and protoxide of iron, containing, besides, alumina and some silica. It is readily fusible, and holding a small amount of the carbonate of lime, it assists materially in fluxing the more refractory ores with which it is mingled in the furnaces. It is of very variable thickness, the proportions of its metallic iron ranging from 25 to 45 per cent. It is impossible at present to make any exact quantitative estimate of the extent of this interesting iron ore along its line of outcrop, so irregular is the topography of the belt it occupies, and so variable are the circumstances which control the presence or absence of that degree of purity which is essential to its being profitably mined and smelted. But that it prevails in great abundance must be obvious from the mere consideration of the long line of outcrop, the wide belt over which it is spread by its gentle dip, and the consequently thin covering under which it lies around the margins of the hills.

IRON ORES OF THE COAL-MEASURES.

Ore of Coal E.—Pursuing, as with the coal-beds, the ascending order, the first bed of iron ore in the Coal-measures of the Scranton Coal-field is the layer of large nodules or balls of clay iron-stone, or argillaceous carbonate of iron, which underlies at an interval of a few feet the large Coal-seam F. The most abundant deposit of these balls is in the Stigmaria shale or fireclay immediately beneath the little Coal-bed E. Here the masses, generally 2 or 3 feet in diameter, lie usually in a single course, the balls not being in contact, but sometimes two or three diameters asunder.

They are of a blue colour, compact and excessively hard, and are of the structure of *Septaria;* that is to say, they have been fissured from the centre outward by shrinkage, and the crevices filled with infiltrated crystalline quartz, brown spar, sulphuret of iron, and sulphuret of zinc. Externally they are of a light bluish-grey colour, and less rich in iron than within, and are marked with the rootlets of the Stigmaria traceable a short way below their surfaces, showing them to be true concretions. Iron made of this ore alone is remarkable for its great toughness and strength, and hence the variety is in much request for mixing with the other ores smelted at the Scranton Iron-works. The principal ore-drifts in this layer are situated upon Roaring Creek, and are quite contiguous to the furnaces.

Blackband Ore of Coal F.—The next layer of ore is a coarse, compact, anthracite *blackband,* occurring in the black slate and shale bed which immediately underlies the great Fourteen-feet seam of coal on the Lackawanna W. of Scranton. This ore is of a bluish-black colour, not very dense in texture, and is between 4 and 5 inches in thickness. Under certain circumstances of mining it might be economically wrought, and would prove a useful ore if mixed with the other varieties. The blackband ores of the anthracite measures are, however, not to be confounded in their properties with the genuine blackband of the bituminous coal-fields, since these latter, by virtue of the bituminous matters which they contain, are much more likely than the former to purify themselves, in the process of roasting or of smelting, from any sulphur which they may contain. This ore contains much carbonaceous matter, and ought therefore to make a good iron after roasting. When reduced to powder, it effervesces actively with *hydrochloric acid,* which shows that it contains some carbonate of lime, another useful constituent tending to facilitate smelting.

Nodular Ores of the Coal-seam K.—In the upper part of the Coal-measures, immediately beneath the Coal-bed K, and also under its rider L, there occur two beds of good nodular clay iron-ore.

The balls which underlie the first named of these coals are irregularly scattered in a blue sandy shale, and unless where very favourably exposed for surface-stripping, are for the most part too coarse and lean in iron to repay the cost of collecting. Those which adjoin the little Coal L occur in its under-clay, a soft argillaceous shale. They are in greatest abundance within 7 feet of the coal-bed, though some occur in a fireclay next beneath this, reposing immediately on the Coal-seam K. These nodules are usually spheroidal in shape, and vary from the size of an egg to one foot in diameter. The quality of this ore is good, it being a tolerably pure, heavy, and nearly homogeneous protocarbonate of iron. The balls weather of an ochreous-brown colour, and exfoliate in concentric scales of peroxide of iron, showing them to contain some carbonate of lime, and to be a little sandy. Under advantageous positions for mining, this ore, the abundance of which is very considerable, may be wrought, both by stripping and drifting, at a cost quite within the limits of economical production.

OTHER IRON ORES SMELTED AT SCRANTON.

Surgent fossiliferous ore is smelted at the Scranton furnaces; it is brought from Clinton County, New York, and costs at the furnace 3 dollars per ton. The ball ore brought one-fourth of a mile from the Coal-measures costs 3 dollars 50 cents. The mountain ore from the mines on Stafford

Meadow Brook, brought 6 miles, costs 1 dollar 75 cents. Limestone, from Limestone Ridge, below Berwick, brought 60 or 70 miles, costs 1 dollar 50 cents per ton. Two tons of the limestone are required to flux out one ton of metal. The mountain-ore makes a very *red short* iron; the Clinton fossiliferous ore a *cold short* metal; the two are therefore smelted together.

ROARING BROOK FALLS.

This waterfall near Scranton is a series of low cascades, followed by a single fall of about 20 feet. The channel of the stream above is worn in the lower plates of the Seral conglomerate, but the principal fall starts from the upper surface of the Umbral rocks, and the wild narrow gorge below is cut out of these rocks. The lower beds of the conglomerate are quite coarse, some of the pebbles being 2 or 3 inches long, and most of them more than one inch in diameter. The higher beds are generally less coarse. About 15 feet above the base, a dark-grey coarse sandstone takes the place of the conglomerate. Above this the rock is conglomeritic, and in some places quite coarse. The thickness of this, as exposed in the grand cliff above the falls, is about 50 feet. The dip of all these rocks is N. about 15° W. at an angle varying from 5° to 12°. The accompanying sketch will convey an idea of the principal fall.

ABSENCE OF COAL IN SPRING BROOK VALLEY, SOUTH OF THE LOADED TRACK.

A gentle Anticlinal, Axis No. VIII., crosses Spring Brook, a little S. of the Empty Track on the W. side. Its S. dips are very flat, being not more than 3°.

From this very gentle flexure not the most trivial dip to the S. is visible all the way up the valley to its turn at Dolph's Mill, where the soft Vespertine rocks outcrop, and are excavated as at the Stafford Meadow Mines. The conglomerate first reaches the water-level of the valley below the road, crossing not more than half a mile above the Empty Track trestling; thence it ascends in an inclined plateau to its last outcrop S. of the East and West Valley of Dolph's Mill. The Umbral formation rises to the bed of the valley at the house half a mile S. of the trestling. It shows nowhere any red shale, but a little reddish sandstone; and its lower beds are calcareous at the foot of Plane No. 5, &c. As might be inferred from this persistency of N. dips, there is no actual basin S. of the Loaded Track to contain even the lowest coals which outcrop N. of it on Spring Brook.

To the E. of Slope No. 3 the coal runs out, for Joel Hale bored about 300 yards to the E. of the slope, beginning on one of the underlying small coals, and he went down about 150 feet, but found no large coal. The dips on the side of the creek are S. 70° E. from the slope.

David Rau & Co. informed us that they bored for coal on the Loaded Track about one-third of a mile N.E. of the head of Plane No. 3. They assert that they have on their land the outcrops of a coal, 8 feet thick, at 100 yards S. of the Loaded Track. The dip is very gentle to the N. Section at Rau's boring :—

	Feet.	Inches.
Hard rock and slate,	60	0
Coal,	0	18
Sandstone and slate,	40	0
Coal,	14?	0

CHAPTER IV.

THE PITTSTON AND MILL CREEK DISTRICT.

GENERAL SECTION OF THE PITTSTON AND PORT-GRIFFITH COAL-MEASURES.

BEFORE entering upon a systematic description of the anticlinal flexures of the third district of the coal-field, it will be expedient to become acquainted with the strata themselves. These are therefore here illustrated in a columnar section, compiled from observations and measurements made at Pittston and Port-Griffith, and checked by the data derived from the Pennsylvania Company's mines and borings. The Section, which sufficiently explains itself, indicates as many as seven coal-beds above the base of the main Pittston Seam. A comparison of these with the beds of the upper Coal-measures exposed by mining near the mouth of Mill Creek (see fig. 256), shows, even in this short distance, considerable variations, nor is it indeed practicable, in the present superficial and unadvanced state of the mines, to identify all the members of the two groups. The two Sections will, however, much assist the reader to an understanding of the following descriptions of the flexures of the strata, and of the coals contained in the sub-basins.

FIG. 276.—General Section, Pittston and Port-Griffith.

By the Pittston and Mill Creek District we mean the whole belt of country S. of the Susquehanna, which is embraced between the meridian of Spring Brook and that of the mouth of Mill Creek, including the region S. of this stream and Gardener's Creek, as far as the parallel of the mouth of Laurel Run. This tract includes eleven or twelve regular and parallel anticlinals, characterised for the most part by much less gentle dips than belong to the flexures of the country to the N.E. of Spring Brook. Intermediate between some of these are several subordinate anticlinals of less force and shorter length. These disturb the regular basins of the coal between the larger ones, and materially affect the facility of systematic mining, though they exercise but little influence on the external features of the country; nor are they important in deflecting seriously the outcroppings of the coal-seams.

The members of this large group of anticlinals are beautifully arranged in an oblique parallelism, or in echelon, from the Lackawanna to Mill Creek.

Axis VI., *or that of Morgan's Mine.*—The first or most Northern of the series, Axis VI. of the Map, crosses Spring Brook and Mill Brook near their entrance into the Lackawanna, ranging in the usual direction, or about S. 70° W. It lifts the upper Pittston Coal to above the water-level in the ridge next S. of the Lackawanna, where it is worked in a mine entering on the arch of the axis at Morgan's Mines. To the N.E. of Spring Brook this anticlinal seems scarcely to be felt, for in its range we meet a great prevalence of N. dips.

Axis VI. A.—North of the axis before us there would seem to be an insignificant shorter one, a little S. of the main road, visible in a coal-drift and ravine a third of a mile S.W. of Babb's.

Axis VII. The next leading anticlinal in due order S. is one of very considerable length, and of an obvious though moderate degree of flexure. It ranges from Spring Brook, where we find it between the trestlings of the empty and loaded tracks of the railroad as they cross Spring Brook Valley, and it passes Mill Brook below the foot of Plane No. 3, being finely exposed on the back road near Barnum's Mine. Thence it extends straight to the termination of the ridge, carrying it to the bluff hill-side E. of the canal, where its N. and S. dips are well developed in the arch of the Pittston Seven-feet Coal, in the S. leg of which occurs Price's, and, in the Northern, Schooley's Mine.

Strata lifted by Axis VII.—This anticlinal, evidently the lowest Coal-measures, elevates at its Eastern development on Spring Brook. Near this line of elevation, on lands owned by Mr Ran, an 8-feet coal, and a still thicker inferior seam, have been proved, the former by mining, the latter, it is alleged, by boring; and these coals we regard as lying far below the Pittston upper series. The statement respecting the boring is, that, starting below the level of the outcrop of the Eight-feet Coal, it crossed another bed 18 inches thick at the depth of 60 feet, and, 40 feet deeper, ended in a coal 14 feet in thickness. If really a coal 14 feet thick does exist here,—but the absence of any such on Spring Brook throws a strong doubt upon the correctness of the measurement,—it cannot be the Pittston large seam, for the obvious reason that the final outcrop of this is known to lie far to the N. On the back road at Barnum's Mine the arch of the anticlinal embraces the Pittston Seven-feet Coal, or the Port-Griffith Fives (so called); and a little to the E. of this outcrop, at a lower level by some 50 or 60 feet, there are topographical and other indications of the presence at the surface of the large Pittston Coal, or the Fourteen-feet bed. Neither of these coals has been traced or identified to any considerable distance E. of this point in the basin N. of this anticlinal. From the point of exposure of the Pittston Seven-feet Coal, on the back road at Barnum's to near the end of the ridge towards the river, this coal, though above the water-level, does not expose any outcrop, being saddled by higher rocks; but the end of the arch towards the river being cut away, the coal is there denuded and accessible, and has accordingly been mined, as already intimated. The large Pittston bed is not, however, lifted on the back of this anticlinal to the water-level of the Susquehanna.

Axis VII. A.—Between this flexure and that of Morgan's Mine is a feeble swell of the strata arresting their general N. dip. It is seen in the hill a little S. of the Catholic chapel. The effect of this is to lift back the Pittston Seven-feet Coal, and to repeat it in a second N. dip, where it is mined by Benedict. It does not seem that this trivial flexure extends any great distance E. The strata embracing an 8-feet bed of coal visible near the Powder-mill on Spring Brook, have N. dips proceeding from this axis, and to the same flexure concurring with the general tendency of the strata we may refer the N. dips visible between the Spring Brook Valley and the Lackawanna.

Axis VIII., *or that of the Iron Foundry.*—We come now to another anticlinal, quite as extensive as the previous one, and not far from it. We first detect it to the E., on Spring Brook, a few hundred feet above the trestle-work crossing of the empty track. Here the flexure is extremely flat, the S. dip not exceeding perhaps 2°, and the N. not more than 4° or 5°. This anticlinal is conspicuously exposed on the back road on the Barnum ground S. of an abrupt hill, the result

of an upthrow or dislocation in the line of the axis. From this point the saddle is traceable to the end of the ridge facing the Susquehanna.

Strata exposed.—At the river the axis is denuded, and the Pittston Seven-feet Coal is laid bare just above the level of the turnpike, opposite the Iron Foundry. The fault connected with this anticlinal, detected by mining operations at the base of the bluff hill adjacent to the back road, uplifts the strata on its N. as much as 50 or 60 feet, placing the Seven-feet Coal, which to the S. of the axis is at the level of the valley, high on the side of the hill to its N. On Spring Brook, about 3 miles to the E. of this point, the strata, exposed in a scarcely perceptible flexure, seem to be those of the very lowest portion of the Coal-measures, for it is only about one-third of a mile to the S. of its position that the conglomerate base of the Coal-bearing rocks rises out to the level of the valley of Spring Brook, the strata in the space between ascending, moreover, with an extremely gentle inclination. It is obvious, that between the valley of Spring Brook and the valley of Mill Brook, along this anticlinal, and indeed on both sides of it, none but the lower Coal-measures are lifted to the surface; nor is it till we cross the Loaded Track, or even approach the main back road, that we meet with what are called the upper Pittston measures. A little S. of that road, however, we may detect the outcrop of the great Pittston Seam swinging N., and then E., for a fourth or a third of a mile, to basin out in the synclinal trough which lies between the axis we are considering and the previously-described anticlinal N. of it. From the neighbourhood of the fault on the back road, to near the end of the ridge at the river, the Pittston Seven-feet Coal-bed is, for the chief part of this distance, saddled over and concealed by higher strata.

This Pittston Seven-feet Coal comes to the water-level at the Tub Spring beyond the bridge, on the main road. (I understand this to be on the first anticlinal axis N. of Pittston.) It then sinks to the N., coming up to the water-level of the valley at Price's Opening at the foot of the next hill, where it is wrought on a S. dip. The next hill is that of the Catholic chapel, containing the next anticlinal, which is broad and flat. This latter axis passes several hundred feet S. of the chapel. Spanning the axis, the coal goes in again at the water-level at Schooley's Drift, about 100 yards S. of the Catholic chapel. Here it passes a little below water-level, and rises again on a very depressed arch, the axis of which is a little N. of the chapel, and, dipping N., is entered at water-level at Benedict's, about 300 yards N.W. of Schooley's. This latter is but a subordinate roll on the N. flank of the previous axis.

Axis IX.—The next anticlinal which claims a place in our account of the principal axes, is that which passes S. of the borough of Pittston. This important and very regular saddle first shows itself in the country between Mill Brook and Spring Brook, but does not, we believe, exist as a perceptible flexure at the valley of the latter stream. It is seen a little W. of Mill Brook, in the ridge just S. of the head of Plane No. 22, where the rock-cuttings on the Empty Track display both its N. and its S. dips, and where one of the lower coal-beds has been entered on the S. flank of the arch. From this intersection the axis, ranging along the summit of the well-defined anticlinal hill, on the S. slope of which runs the Empty Track, is again well shown near the head of Plane No. 2 of the Loaded Track, where the Big Pittston Coal is mined on both its slopes. Passing now a little S. of Plane No. 2, and a few hundred feet to the S. of Shaft No. 1, the axis appears distinctly marked in a well-developed arch, just W. of the Pittston Brook, where the natural exposure of the strata has been assisted by the railroad-cuttings for the Loaded Track.

It ranges through the S. brow of this hill, keeping a little to the N. of the Plank Road, and growing somewhat fainter in its dips, comes out on the canal in the broad gentle arching of the strata, there visible in the higher portion of the sandstone cliffs.

Strata lifted to the Surface by Axis IX.—Lifting, as we have seen, only the lower Coal-measures to the E. of Plane No. 22, this anticlinal in its declension W. allows the upper Pittston coals to saddle it in the vicinity of Plane No. 2. Here, at a distance of about 1000 feet E. from the head of the Plain, the outcrop of the large Pittston Coal-seam swings over the arch of the anticlinal ridge, passing through a depression in its crest from the S. to the N. flank. Further W., at a considerable distance, but concealed by a deep deposit of drift, the upper Pittston Coal, or Seven-feet bed, likewise saddles this axis, but the precise position of this turn, somewhere S. of the foot of Plane No. 2, is not ascertained. In the natural arch W. of the Pittston Brook and the Loaded Track, the large Pittston Coal-bed, which we have seen outcropping so near the head of Plane No. 2, is here 20 feet beneath the bed of the stream, and not accessible to mining except by machinery. At the canal, above the river-side, the small overlying Eighteen-inch seam of coal, 40 feet higher in the strata than the large bed, just lifts itself above the level of the tow-path at the point of the anticlinal, very soon to disappear again; and here, therefore, the large bed itself lies on the back of the anticlinal, even below the bed of the Susquehanna River.

Basin 9.—In the basin included between this last and the previously-traced anticlinal axis, lie, of course, the lower coals in the vicinity of Mill Brook, and further to the W. the upper Pittston series, basining out as they cross the Loaded Track about 1½ miles from the river. But in this broad synclinal trough are included either three or four subordinate short anticlinal flexures, which we now proceed to describe.

Anticlinal No. IX. A, *or the most Southern visible on Spring Brook.*—The synclinal belt S. of the main anticlinal No. VIII. exhibits on Spring Brook, at a distance of about 1000 feet from that axis, a depressed arching of the strata, the last flexure in our progress S. to be detected, until we pass the conglomerate, or the boundary of the Coal-measures. This saddle is so feeble that its South-dipping portion is almost flat. It may be discerned on both sides of the valley.

Anticlinal No. IX. B.—Coincident in position and direction with the preceding flexure, or Axis No. IX. A, is a more decided arching of the rocks, visible on the road and canal one-fourth of a mile N. of Pittston. It passes the river road close to the spot at which the middle road branches off from this, or just S. of the old tavern.

Though the identity of these two saddles is highly probable, we are unable, in the present state of things, to trace them into each other, and it is therefore most convenient to give them provisionally separate designations.

The Axis No. IX. B exposes at the canal the rocks which immediately overlie the upper Pittston or Seven-feet seam of coal. Even here, at its most W. visible point, this flexure is extremely gentle, its steepest dips not exceeding a very few degrees.

Anticlinal No. IX. C.—This axis shows itself in the canal-cutting close to the S. end of the Pittston Bridge, displaying on the N. turn of the arch a sudden folding of the strata, with marks of dislocation. It lifts to a small height above the level of the canal the Pittston Seven-feet Coal, which otherwise would basin here deeper under the town.

Anticlinal No. IX. D.—A fourth intermediate axis displays itself in the cliffs on the river-side,

on the edge of the canal. It is the more North-Eastern and feebler of the two flexures there visible. It is prolonged through the hill, bounded by these cliffs, ranging a few hundred feet N. of the main anticlinal, of which it may be considered a subordinate wave on its N. flank, and passes a little to the N. of Shaft No. 1, the position of which is not far from the centre of the basin embraced between the greater and this lesser axis.

Strata lifted by it.—The effect of this small undulation has been to expand the width of the hill in which it lies, and to spread and hold up the breasts of coal contained between the river-side and the main anticlinal.

Anticlinal No. IX. E.—Connected with the great leading anticlinal we have been describing, is another subordinate one, lying parallel to it on the S., and, like the last small one mentioned, chiefly visible near the W. end of the anticlinal belt. It shows itself S. of the Plank Road, except near the canal, where the axis is N. of this line. But E. of the arch seen on the Loaded Track this saddle is not continuously traceable, but seems rather to be marked by a succession of elongated elliptical upthrows. This line of elevation will pass near the pond adjoining the Loaded Tract.

Anticlinal No. IX. F.—Adjacent to the same anticlinal at its W. end, but several hundred feet to the S. of it, there occurs another short saddle, crossed by the Empty Track not far to the N. of the head of Plane No. 1. This anticlinal is not visible for more than a third of a mile.

These, and perhaps other still more subordinate flexures, undulate the wide Port-Griffith Basin embraced between the main Pittston anticlinal and the important leading flexure which we have next to trace. In this comparatively broad basin of the Port-Griffith Mines we encounter another line of anticlinal uplifts, which either is a continuous axis or a merely linear succession of elliptical upthrows, ranging from a little N. of the Pennsylvania Company's Slope No. 4 across the old stage road at Schaeffer's, and passing just N. of the Port-Griffith Slope No. 1; it is probable, indeed, that this anticlinal commences still further E. in the meridian of Slope No. 4, for such at least is implied in the sweep which the outcrop of the great Pittston bed takes in this vicinity. The actual basin of the Port-Griffith Eight-feet Vein, and likewise of the Pittston Seven-feet, from Schaeffer's eastward at least, is embraced between this anticlinal belt and the larger anticlinal range which next succeeds it on the S. To this latter we will now proceed.

Axis No. X., *or that of Plainville.*—The anticlinal wave to which we have now arrived is apparently not a single axis, but, in its Western part at least, seems double. We meet with it first in the vicinity of Mill Brook, encounter it again in clear development at Yates's, whose farm-house is seated immediately upon the back of the saddle, and we may trace it thence through the crest of the long ridge which ranges W. from his place as far at least as Winter's Lane; here we meet with indications that this anticlinal belt includes in reality two axes, the main one, probably that of Yates's House, passing onward in a strictly straight line close to Williams's Store, and so out to the Plank Road, a fourth of a mile N.E. of the Plank Road Hotel.

Anticlinal No. X. A.—Another or attendant axis, lying some 700 feet to the N. of the main one, seems to range from near the mouth of Winter's Lane along the crest of the ridge just S. of the main road until it passes almost directly by the Methodist Meeting-house, from which point, continuing its course, it ranges through lower ground till it shows itself distinctly in the banks of a brook at the intersection of this with Maxwell's Railroad, whence it is prolonged till it reaches the canal a little W. of the crossing of this by the Plank Road. This main anticlinal, as we regard

it passing Williams's Store, is accompanied by another undulation of the strata not 200 feet to the N. of it, the position of which is almost directly under his house.

Strata Elevated.—Of the strata lifted by this anticlinal along the E. part of its range, we know at present very little, except that they must consist of the lower Coal-measures. To the W. of Yates's, however, we find that the Main Pittston Seam laps over this anticlinal arch at the E. end of his hill, and a little further W. is itself saddled over by higher strata—Yates's Mine being here on the S. slope of the wave, and Stout's Opening on the N. From this place the E. limit along this belt of the main Pittston Coal, this valuable stratum, traced forward to the W., keeps under cover throughout the whole broad crest, and under the whole N. flank of the ridge as far as it extends; nor does it outcrop on the S. or opposite side of the axis until it is undulated by another and more subordinate anticlinal, lying some 800 feet or so to the S. of the principal one.

The effect of the principal axis of this anticlinal belt is, as we have seen, to lift the main Pittston Seam high above the water-level in the hill W. of Yates's. But in the vicinity of Williams's Store, estimated to be some 2½ miles from this point, it barely brings to the lower levels of the country the coal which we have called the Pittston Seven-feet Seam, the place of which is at least 120 feet higher in the strata than the main seam above spoken of. We may infer from this, that, in the space of some 3 miles from Yates's to the canal, the anticlinal declines not less than 250 feet.

Basin No. X., *or that North of Axis No.* X.—The broad basin lying to the N. of this anticlinal belt, and bounded on the other side by the main Pittston Axis, contains, as we have already seen, several subordinate short flexures. These occur chiefly in the N. half of the basin, but there is a very feeble one which merely flattens, but does not reverse the dip, passing just at the N. base of the main anticlinal ridge, and to the S. of the New Shaft, No. 5. This we regard as the feeble expression of the anticlinal which we have traced as attendant upon the main one lying N. of it, and passing under the Methodist Meeting-house. As in all the other basins, this N. of the present anticlinal, deepest towards the W., contains there its highest coals, and presents a succession rising out towards the E. of lower and lower strata. The width and consequent depth of this basin is such that it embraces, in the vicinity of Port-Griffith, even a small synclinal patch of a coal found, we believe, nowhere further E. in the whole coal-basin, and which we are disposed to identify with the Nine-feet Seam of the mouth of Mill Creek. This does not, however, possess even enough coal to admit of its being mined. The next subjacent coal of workable dimensions, the Port-Griffith Eight-feet bed, basins out with a spoon-shaped curve only a few hundred feet to the E. of Slope No. 1; and in the same synclinal, the next underlying coal, the Five-feet Twins (so-called), or Pittston Seven-feet bed, have their final Eastward outcrop just a little to the E. the lane of leading S.E. to Yates's.

Within the same basin, though considerably further N. than the synclinal line which marks the basining out of the Port-Griffith Eight-feet and Pittston Seven-feet coals, is the final Eastward outcropping of the main Pittston Seam. This is in that N. subdivision of the chief basin which is called Butler's Basin, and the place of final Eastward outcropping, or the termination of the trough of the large coal, is about one-third of a mile to the E., or rather the N.E., of Butler's Tunnel Mine.

Within this special basin of Butler's Tunnel, the Pittston Seven-feet Seam, here a higher coal

by about 70 feet of interval, has itself a basin-shaped outcrop of much more limited extent, the E. point of which is some hundred feet to the W. of Butler's Tunnel. The isolation in this more Northern basin of the Seven-feet Coal from the other already mentioned as near Yates's Lane, is due, of course, to the interposition of an anticlinal flexure—that, in fact, which ranges N. of Slope No. 4, and uplifts the same Seven-feet Coal in the brook at Schaeffer's.

Axis No. XI.—S. of the last-described leading anticlinal, there exists another at a distance of about 800 feet. This is first seen to the E. in the country W. of Mill Brook, and we have it well exposed in the vicinity of Yates's, where it forms a little ridge with a double crest, and divides the small basin of Yates's Coal from another narrow trough of the same bed S. of it. About half a mile W. of Yates's we detect this saddle arched over by the conglomeritic sandstone which underlies at some distance the large coal; and though we meet no exposures indicative of it on Winter's Lane, from the obscurity caused by drift, yet the form of the ground there implies its presence; while still further W. on the lane leading back from near the Methodist Meeting-house, conclusive proofs of this axis are discoverable. Further to the W., we discern no positive traces of it either on the lane running S.E. from Williams's Store, or in the intervening ground.

Strata Elevated.—The effect of this anticlinal upon the Coal-measures is to form, with the main anticlinal of Yates's Ridge, a basining of the coal on the S. flank of the principal axis, and it is at the E. end of this slanting trough that Yates's Mine in the large coal is situated.

Basin XII.—This serves to insulate the narrow trough of the large coal to the S. of it, the last outcropping of which in that direction is determined by the general rise of the country, and the presence of decided N. dips belonging to the next anticlinal. The E. limit of this most Southern basin of the coal is not precisely definable, though it is obvious, from the rising out of of the little valley containing it, and its Westward dip, that the point is but a little to the E. of the meridian of Yates's house. It is this S. basin which includes the openings belonging to Wells, Armstrong, and Bennett.

Axis XII., *or that of Bennett's Big Coal.*—The anticlinal which next succeeds has been but imperfectly determined to the Eastward of Gardiner's Creek. It is that which produces the N. dip of the final outcrop of the main Pittston Coal, and, in virtue of this fact, it possesses considerable interest, for a part of its range it coincides pretty nearly with the course of the back road N. of Gardiner's Creek. This axis, or regular flexure, which we deem it to be, may be seen just N. of the extreme Northern bend of Gardiner's Creek, opposite Venison Hill, lifting the rocks subjacent to the great coal-bed. We may trace it thence, in the topography and in the dip of the strata, to the little brook which passes Maxwell's Mines, in the bed of which stream we may recognise the axis lifting a small coal, which lies next below the great one. A mile and a quarter to the Westward this flexure may be still detected with much enfeebled dips in Carey's Lane, very near his farmhouse; and we have the plainest indication of it, even though in very gentle dips, on the Plank Road, near the canal, about a fourth of a mile above Wordin and Hale's Colliery.

Strata Elevated.—Adverting to the strata lifted by this axis, it is important to remark, that throughout all its range Westward, from its origin to the brook at Maxwell's, it is nowhere saddled by the main Pittston Coal, or any of the upper Coal-measures, but is the immediate barrier which confines their line of outcrop in extending Southward; whereas to the Westward of that brook, the declension and flattening of this anticlinal permits the productive upper

measures to arch across it at Williams's Lane, and place their outcrops in the next main basin to the S. of it, till they encounter a deflection from another anticlinal, across which they pass in similar manner to reach the banks of Mill Creek, and vanish under the deep covering of drift which fills the valley of that stream. The lowest strata elevated in the arch of this anticlinal, at its last exhibition on the line of the Plank Road, are those immediately beneath the Hollenback Twelve-feet Coal-bed, a seam which we are disposed to place at an interval of some 100 (?) feet in the series above the horizon of the main Pittston Seam.

Axis XIII.—To the anticlinal last described succeeds another of considerable importance. From the undeveloped condition of the country E. of Gardiner's Creek, it is impossible to trace this axis in that quarter, though the presence there of a saddle in its general line of bearing leads to the inference of its existence. It is first definitely recognised in Venison Hill, and in the two reaches of Gardiner's Creek which enclose this elevated knob. Beyond this to the Westward the saddle shows itself on Williams's Lane about two-fifths of a mile N.W. of the point where the lane crosses the creek. Here an axis, directly in the bearing of that of Venison Hill, exists, which we must regard as the same. Topographical features and anticlinal dips indicate it about a third of a mile further Westward, and we meet evidences of it again in the vicinity of Wilcox's Mine, where the outcrop of the large coal-bed gives indeed ample proof of its presence in the curving sweep which that seam takes Northward and then Northeastward from Mill Creek. We detect what we regard as the same axis at a stage further Westward on the lane leading up the hill near Miner's Mill. The place of this saddle is well defined again on the Old Wilkesbarre and Pittston Road, where it passes very near the dwelling-house of Charles Miner ; thence we may trace it down to the Plank Road and Canal, where, on the bank of the latter, the arch is well exposed, lifting the sandstone strata which next underlie Hollenback's Twelve-feet Coal-bed, the two outcrops of which, upon opposite dips, serve to establish well the form and position of the flexure.

Strata elevated by the Anticlinal.—It thus appears that this axis, in its subsidence Westward, after permitting the main Pittston Coal to saddle it near Wilcox's Mine, allows the higher, Hollenback Seam, to arch nearly over it between the Stage Road and the Canal, marking a declension, in the space of about a mile, of more than 100 feet. That the Hollenback Twelve-feet Coal does not entirely close over the back of the anticlinal is seen in the fact that the mine in this bed on its N. dip, Eastward from the Plank Road, proves to have a separate outcrop all the way to the Old Stage Road, near Mr Charles Miner's barn.

Basin XIII.—Within the basin included between this leading axis and the one preceding it in our description, there occurs an unimportant local flexure visible on Williams's Lane some 600 feet to the Northward of the axis No. XIII. which we have been last discussing. We have been unable to detect any distinct traces of the presence of this undulation Westward of the outcrop of the large coal-seam, but are disposed to impute a part of the Northward displacement of that outcrop near its intersection with a lane leading to Mill Creek, to the gentle lifting of the Coal-measures by this flexure.

The same basin N. of our main axis insulates a trough of the Hollenback Twelve-feet Coal, the E. termination of which must be somewhere S. of Spearing's Tavern. To the Westward of this, and much nearer to the Plank Road, will be found the E. end of the much smaller included or concentric basin of the next higher coal, worked by Wordin and Hale,, the two outcrops of which are visible at their mine :—

Hollenback's Coal.

	Feet.	Inches.
Coal,	1	2
Slate,	0	2
Sound coal,	3½	0
Slate-parting,	0	1
Sound coal (blacksmith),	2	8
Slate,	0	2
Bony coal,	1	2

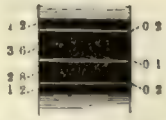


FIG. 277.—Hollenback's Coal at opening near Canal.

All these benches but the lower one are worked.

The Hollenback Coal crops out on the N. side of the basin with a gentle S. dip of 10°. Here it has been entered by a drift.

Axis XIV., *or that of Miner's Mill.*—We come now to an anticlinal, the most Southern of the larger ones embraced within the limits of the Pittston district, as I have defined this, disregarding the township boundaries. This axis, lying about 600 or 700 feet to the S. of that previously mentioned, is well exhibited from the river to the main road; but beyond this the continuity of exposures is so much interrupted by the covering of drift along the valley of Mill Creek, that we discover but few indications of it till we approach the N. side of Gardiner's Creek above its mouth. Here, on the lane leading from that stream to Williams's store, and some 800 feet from the creek, we find a regular gentle anticlinal, which, from its position, we cannot but refer to the axis we are tracing. Again, in the prolongation of this line Eastward through Venison Hill, and still further to the main bend of Gardiner's Creek, when it turns from a N. course to a W. one, we discover very plain evidences of the same axis. That it extends into the district between Gardiner's Creek and Mill Brook there can be very little doubt, but its identification there is not at present practicable.

Strata elevated by Axis XIV.—On Gardiner's Creek this anticlinal, which is the second N. of Thomas's sawmill, lifts out to the surface some of the rather higher members of the lower coal series. The same strata appear to arch it in the ridge N. of the lower reach of Gardiner's Creek. But where this anticlinal passes under the flats of Mill Creek in the vicinity of Miner's Mill, it must be manifestly overlapped by the main Pittston Coal, or the lower members of the upper series, and from this point forward to the river it elevates to the surface higher and higher Coal-measures, the uppermost between the main road and the canal being the 6-feet bed overlying the large Hollenback Seam, and the fourth in descending order from the top of the whole coal series, as we at present know it in the vicinity of the mouth of Mill Creek, or anywhere, indeed, within the region. The point of this anticlinal is well exposed at low water on the shores of the Susquehanna.

Axis XV., *or that S. of Gardiner's Creek.*—The next anticlinal which we may include within this district lies chiefly S. of Gardiner's Creek. It is that seen N. of Thomas's sawmill, some 700 or 800 feet from it. It ranges through Johnson's Cabin Ridge and the Southern part of Venison Hill, crosses Gardiner's Creek in the lane leading thence to Williams's Store, about 1200 feet above the mouth of the stream, being visible in the brow of the hill ascending Northward from the water. The gentle N. dip which we find on the Parson or Back Road just N. of its intersection with Mill Creek, belongs obviously to the Northern flank of this axis; but

further Westward than this spot we are prevented from following it, as the wide plain of drift in the valley of Mill Creek effectually conceals the strata. No trace of an axis corresponding to this one has been noticed anywhere in the hill N. of Mill Creek, or the mouth of Laurel Run, in the prolongation of this anticlinal, and we are, therefore, compelled to infer that it dies away in the valley of Mill Creek.

Axis XVI., *or that of the New Haven Mine.*—Succeeding this imperfectly exposed anticlinal, occurs the most Southern well-defined axis of the district. It is that which is so well exposed on the canal, about one-half of a mile below Wilkesbarre, where the very position of the turn of the dip may be detected, and its place identified with the little ravine which separates the two first cliffs or rock-cuttings of the S. bank of the canal. We detect its place again just S. of the deep cut in the Plank Road next S. of Mill Creek, and a third time we find it well exposed in the knoll of the hill on which is seated the School-house, at the separation of the Middle and the Mill Creek roads. From the School-house the anticlinal ranges to near the mouth of Laurel Run, beyond which it is lost for a space under the sheet of drift which fills the valley between Laurel Run and Mill Creek. Traces of this axis reappear again in the topography on the Parson Road, and we have a flexure which we regard as it, beautifully developed, much further E., at what is called the New Haven Coal-opening on Mill Creek, near the mouth of Cold Brook. Further Eastward than this last-named exposure this anticlinal has not been traced.

FIG. 278.—Section at the Canal below the mouth of Mill Creek near Wilkesbarre, at the anticlinal flexure No. XVI.

Of the Strata lifted by Axis XVI.—It is impossible specifically to identify the particular Coal-measures elevated by this anticlinal to the surface, throughout all its Eastern range. We feel assured, however, that the coal-bed which so regularly arches the axis on Mill Creek at the New Haven digging is a member of the lower Coal-measures, but almost certainly a higher stratum than the great Baltimore bed. At the Schoolhouse Hill on the Old Stage Road, this anticlinal just exposes, in divided outcrops, the second coal-seam of the upper series, with a small depth of the next subjacent strata. On the Plank Road it barely elevates the same second coal and its fireclays to the surface. On the bank of the canal, on the other hand, in consequence of a deeper denudation at the axis, the next lower or third coal descending is just exposed on the back of the arch at the water-level of the canal. The declension Westward of this anticlinal would thus appear to be extremely gentle.

Basin XVI.—The basin or trough enclosed between the flexure we have just been tracing, and that of the vicinity of Miner's Mill, or the first one N. of the mouth of Mill Creek, has its synclinal line very near the intersection of the Old Stage Road and Mill Creek. Indeed, the lower reach of this stream lies but a little N. of this deepest line of the trough. Within this trough, from the river to that part of Mill Creek extending from the mouth of Laurel Run to Miner's Mill, we have the uppermost or Wilkesbarre coal series exposed on both their N. and S. outcrops, as any one may easily discern who will closely inspect the strata intersected by the canal, or by the Plank Road, or by the old road leading to Pittston. These coals are the first and second descending, and on the N. side of the basin of the Plank Road the third or 9-feet seam is visible

likewise on the river-side immediately N. of the aqueduct which spans the mouth of Mill Creek.

Basin XVII.—South of the anticlinal belt which we have last been tracing, there is a broad belt extending in length the whole distance from Wilkesbarre eastward to the upper part of Mill Creek, remarkable for the paucity of exposures of the strata, and for the consequent obscurity which rests upon it as regards its geological structure. Separating as it does the Pittston and lower Mill Creek Coal-measures from those exposed S. of Wilkesbarre, it cuts us off effectually, for the present, in every effort we may make to connect and relate the lower series of coal-rocks and coal-beds embraced between the conglomerate of the Southern margin of the valley, and this belt, with those upper members lying on the other side of the anticlinal, and which extend from it to the river and the Lackawanna. Nevertheless, we do not despair of linking together the two groups at some future day, when the middle parts of the formation, cut by the waters of Gardiner's Creek and Mill Creek, shall have been developed by systematic mining. Within this obscure tract there are all the topographical indications of a flat anticlinal in the vale E. of Wilkesbarre. The position we would assign to it is the rounded summit of the very regular low ridge passing through the farm of Judge Conyngham. If the strata whose outcrops are concealed under the smooth fields and meadows of this valley were once exposed, by either a systematic line of trial-shafts, or by one or more deep borings judiciously located, the whole problem of the relations of the upper to the lower coal series of the Wyoming coal-basin might be readily solved, and some very important practical questions—that, for example, of the depth of the Baltimore coal-bed under the town of Wilkesbarre—satisfactorily answered.

WORKS OF THE PENNSYLVANIA COAL COMPANY AT PITTSTON.

1. *Shaft No.* 4.—This shaft is immediately S. of the Pennsylvania Company's office; it has a depth of 100 feet. The coal was reached 76 feet below the surface; it is in Basin IX., the strata dipping gently N., though there is said to be a small roll in the rocks.

2. *Shaft No.* 3 is about 200 feet S.E. of No. 4, and in the same ravine; it is sunk 98 feet to the 14-feet Pittston vein (which lies in four benches, and contains from 12 to 13 feet of good coal). The dip is gently to the N. The crop of this vein on N. dip is not far S. of the head of this shaft, which is in Basin IX.

3. Back from Shaft No. 3 are the mouths of two sand-tunnels immediately side by side. The Easternmost of these goes in under the hill which lies to the E. of it, into the Big Vein. The other (the Grand Tunnel) is without breast, being covered to prevent the ingress of sand. It follows the ravine (having on its course one or two shafts sunk upon it to procure sand) back as far as the slope now in operation. Before reaching the slope, from which it is designed to carry the coal, it goes through blue sandstone.

4. *The Slope* is rather gently but variably South-dipping, say from 10° to 15°, for 600 feet, when it meets a basin; its end at 750 feet is gently North-dipping. There is, therefore, an anticlinal between Shaft No. 3 and this slope, and a synclinal in the slope. All the mining operations of the Company are regarded as being on the same vein (the 14-feet coal). N. of the slope about 50 feet, a shaft is sunk for the purpose merely of raising the rock cut in the Grand Tunnel, now being driven to the coal.

5. *Shaft No.* 2 is down 87 feet; it may be seen in the next transverse ravine S.W. of that in which Nos. 3 and 4 are situated, about half a mile S. of the Plank Road. The coal (the 14-feet vein) is said to have a gentle N. dip, the shaft being within 100 feet S. of the middle of the basin.

6. *Shaft No.* 1 is situated in the mouth of the ravine on the S. side of the Plank Road. It is sunk 101 feet to the coal, which dips gently S. Behind the shaft, in the bed of the creek, are S. dips in flaggy sandstone. This shaft is near the middle of the small basin N. of Axis IX.

Between shafts No. 1 and 2 and about 1000 feet N. of No. 2, the No. 2 shaft coal rises to the surface, where it has been proved on a S. dip; N. of this the coal disappears, and no N. dips have been found at this locality. In working S. from the foot of No. 1, the coal-bed, in a basin, comes to an abrupt break, from which it entirely disappears, and its place is occupied by sand and drift. It has evidently been torn away by drift, for buried up in the sand are found boulders of coal, bearing evident traces of the transporting action of water.

7. At the upper end of the ravine are several drifts, on what is regarded by the Company as the final outcrop of the Big Vein. This outcrop is traceable Eastward to Butler's, and half a mile Westward to the slopes of the Company.

There is apparently a gentle basin near the trestle of the inclined plane over the Plank Road N.E. of Pittston, or rather a flattening and slight turn from the N. dip at the Mill.

The 1*st Pittston Anticlinal Axis*, or Axis IX. C of the Map, is at the Mill; it lifts the 7-feet coal (so called), or true 5-feet bed, to above the level of the canal about 30 feet in the ravine.

The 2*d Anticlinal*, or Axis VIII., comes to the Plank Road opposite the Foundry. There is an intermediate roll at the Old Tavern, which does not, however, lift the 5-feet coal to the surface, though the 2d Axis *does* so just N. of the brook: it is that of the *fault*.

The 3*d Axis*, or Anticlinal VII. of the Map, is the axis of the Barnum Mine; it comes to the Plank Road between Pierce's and Schooley's mines.

The 4*th Axis*, or VII. A, is a gentle roll, affecting the Schooley's and Benedict's mines; it is not seen on the Back Road.

The line of outcrop of the Big Pittston Coal, on the N. side of the main Pittston axis, after crossing the ridge of Plane No. 2, sweeps down the side of the hill, and, taking the ravine of a small brook, crosses the Loaded Track quite obliquely. The 7-feet, or true 5-feet coal has its outcrop a quarter of a mile to the W. of the large brook crossing the railroad in a similar manner.

The two coals basin in this synclinal trough of the Empty Track about opposite Barnum's Mine on the Back Road.

On the N. rise the strata take a sudden upthrow by a *fault*, to the extent, it is said, of 50 or 60 feet, lifting the 5-feet coals, which are on the side of the ridge, in a flattish N. dip. This fault is probably a part of the axis of this ridge, which is the same anticlinal which reaches the Plank Road at the Foundry. Basining again, the coals spread once more further E. in the narrower and flatter trough between this dislocated axis and the Barnum axis.

This Barnum axis is No. 3 of the Plank Road, or No. VII. of the Map, bringing the 7-feet coal and the 5-feet coal to the surface on the Back Road at Barnum's Mine, where it has been opened near the saddle on a gentle N. dip.

The 5-feet coal comes out near the Plank Road on both dips; it was at one time mined upon the S. dip, nearly in the basin, by Pierce, and on the N. dip in the next basin by Schooley.

N. of this 3d axis, or No. VII., there is no flexure of much force, and only two are visible between it and the Lackawanna. The more Southern of these is that just S. of Benedict's Mine, or a little S. of the Catholic chapel. The other, or N. one, merely lifts Morgan's 7-feet or 5-feet coal to a sufficient level above the canal to allow him to mine it.

The axis of Morgan's Mine is traceable at the bridges on Mill Brook and Spring Brook on the Old Back Road.

These axes, the 3d inclusive, must determine the course of the Big Coal beyond where we see its outcrop, and I doubt not its range is no longer Northward, but North-eastward, or still more Eastward.

In all this quarter the 14-feet coal is reduced to about 8 feet in thickness. May it not therefore be one of the coals near the Lackawanna in the vicinity of Drake's, its identity being lost to observation?

New Mines of the Pennsylvania Coal Company.—This Company's new shaft, No. 5, on the S. edge of Basin X. (see Map), is now sunk to the Big Pittston Coal. Its depth is about 300 feet to the bottom of the coal-bed. The Shaft No. 6, further N. and down the hill, is about 400 feet deep to the same main coal-seam.

Slope No. 2, near Port Griffith, has a perpendicular depth of 415 feet. When it reaches the bottom of the basin, and can drain it, the whole colliery will be in a very fine condition. An inclined plane will let down the coal from Shaft No. 5 at the road to the level of No. 6.

Shaft No. 5 is 10 feet wide by 16 feet long. The average cost of such a shaft in the harder sandstone rocks is about 95 dollars per yard, and 65 dollars per yard for the softer slates, &c.

Shaft No. 7 is in the ravine of the stream, and 600 feet S. of the intersection of the road and the anticlinal axis; it is not deep, is 9½ feet wide by 17½ long, and cuts a small coal very near its mouth, but at the date of our observations (1854) had not yet reached the other upper coal-beds exposed at the anticlinal axis on the road. This shaft is intended to meet the large coal-bed.

Port Griffith.—The Port Griffith section borings were confirmed by outside observations.

	Feet.
Port Griffith Coal, ...	7
Small pebbly sandstone, ...	30
Coal, ...	3

There are the remains of a large coal above the Port Griffith 7-feet coal, at Port Griffith.

The Port Griffith 7-feet coal probably does not reach 1000 feet E. of the Port Griffith slope. It seems to be merely the end of the basin or spoon. There are three gangways running round

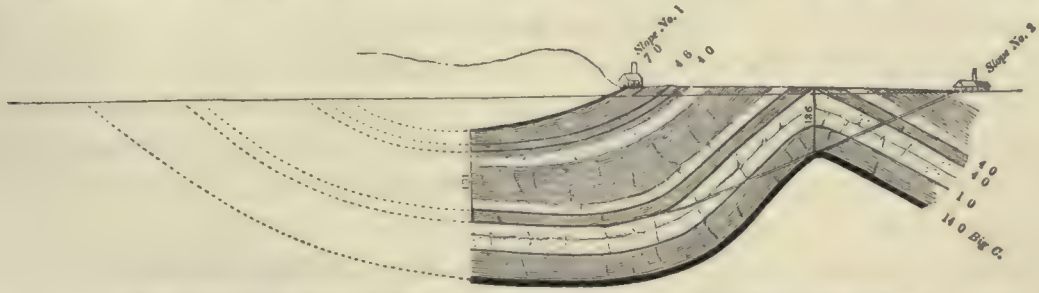


Fig. 279.—Section, Port Griffith Slopes and Borings, from Pennsylvania Company's draught.

it. The bottom of the slope runs into the bottom of the basin; the top of it is to the N. of the synclinal line.

Port Griffith Slope No. 2 was sunk to meet the 14-feet coal in its large basin. It begins in the rocks, and cuts the double 5-feet coal, and reaches the 14-feet coal just at its anticlinal axis. It continues in it a short distance, when this 14-feet coal dips down steeply out of the line of the slope.

The small coal in the stream N. of Shaft No. 6 is above the pebbly rock, and about 50 feet above the small coal 40 feet down in the shaft.

COAL-MINES TRACED FROM WILCOX'S N.E. TOWARDS PITTSTON.

At the Wilcox Mine on Mill Creek the dip is S. 20° W., and this dip is seen at several exposures on the creek until we get below Miner's Mill.

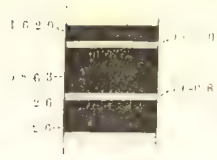


Fig. 280.—Maxwell's Coal.

The upper and lower beds were traced forward to Maxwell's, who was working the upper bed. The small coal which he reached in the tunnel is the small coal between the two main seams.

From Maxwell's we traced the outcroppings of the benches to the opening and boring on Isaac Wilcox's land, thence to the Ben Swallow place at the foot of the orchard S. of the house. Near this we found *the same lower* bed entering the hill S. of the valley, and rising through the hill on its N. dip, to crop out again at Bennett's Mine.

Here the upper bed, still capped by the conglomeritic sandstone, has been opened, but the state of it could not be ascertained: it is evidently thinner than the lower bed. At this place the strata (fissile sandstone and sandy shale) are not less than 70 or 80 feet thick.

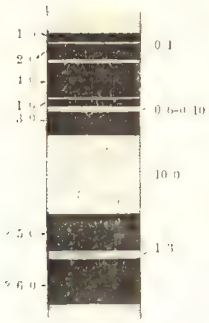


Fig. 281.—Wilcox Coal, Miner's Mill.

This lower bed of Bennett's Opening is 14 feet thick, and contains excellent coal. Even at Williams's the dividing measures are thicker than at Wilcox's Mine. Near Miner's Mill and at Maxwell's they are somewhat thicker and still more sandy, and so they increase in coarseness and thickness all the way to the vicinity of Yates's, in the Pittston Section.

The overlying material is a thinly-bedded grey micaceous sandstone, and immediately over the coal lies a sandy plate. It grows thicker and coarser as we go Eastward; and from the Plainsville Lane a conglomeritic character begins, which forms thence Eastward quite a prominent ridge, from the hardness imparted by the coarseness of the pebbles.

Approaching Yates's, and on Taggart's and Priestley's place, just N. of the valley of the outcrop of the coal, a new feature is displayed in the introduction of an anticlinal axis (No. XI.), which, between Bennett's outcrop and Yates's south-dipping portion of the same bed, forms a distinct basin of this great coal-seam or seams. Opposite Yates's there would appear to be, in fact, two saddles, one (Axis X) at his house, forming the S. dip of his coal-mine, and another in a small ridge to the S. of the mine.

This saddle X is seen at the S. edge of the wood, on the Priestley and Taggart land, lifting the conglomeritic sandstone, the same as at Yates's house, above the level of the meadow. Thus the Maxwell, Bennett and Wells, and Armstrong openings, are on the S. side of one basin, and the Yates Mine is in the basin next to the N.

This small dividing saddle is probably that which passes N. of Maxwell's Mine, while that of

Yates's house must be the more conspicuous one on the main road. The small saddle S. of Yates's lifts the Little Coal to the surface just at the axis, while the larger one lifts only the overlying conglomeritic sandstone at his quarry.

The main outcrop of the Wilcox Coal, going Eastward, swings from a N.E. to an E. course at Maxwell's house, showing the breadth and declension Westward of the wide anticlinal, on the N. flank of which it reposes.

The upper bench of coal over the main lower coal of the Wilcox and Bennett's outcrop, seems to have left this latter by a wide interval when we get as far as Armstrong's Mine.

The Large or 14-feet Coal in the basin N. of Yates's small anticlinal does not extend far to the E. of Yates's land, for it is there opened on the outcrop on the S. side of its basin, where this is quite narrow. From the slope of the Little Valley it is plain that the Little Coal soon lifts itself out Eastward, turning its line of outcrop like the lip of a spoon round the bowl.

On the lane from Yates's out to the main road, we soon meet gentle S. dips, making a flattish basin on the N. side of Yates's main axis. Nearer the E. end of the basin, the Upper Coal—the Wilcox Twins, a bed of Pittston Coal 7 feet thick, dipping W. under the conglomeritic sandstone—is identical in aspect with that which caps the upper Wilcox Coal from the Plainsville or Williams's Lane to Yates's. A little nearer the main road we cross the broad flattish saddle exposed in S.W. and W. dips rounding this same capping rock.

On the main road at Schaeffer's the axis is finely intersected in the ravine of a brook, and lifts a coal, the upper of the 5-feet coals or Twins (?) to the level of the brook, exposing 5 feet of coal overlaid by flaggy sandstone 5 feet thick, and the pebbly rock 20 feet more.

A little W. of Schaeffer's Mill is a synclinal ridge on the road, which exposes both dips of the next higher conglomeritic sandstone, and then a long succession of N. dips brings up the lower conglomeritic sandstone capping the 7-feet bed near the new shaft of the Pennsylvania Company. This conglomerate crosses the road E. of Squire Winter's.

At Cooper Farman's opening there is a coal said to be the 7-feet bed.

At Enough and Tulla the 5-feet Coal seems to be in one bed, and it is 8 feet thick; while at Barnum's the 14-feet seam is reduced to 10 feet of good coal.

We traced the outcrop of the Big Coal and the 5-feet Coal, beginning where the outcrop crosses the Loaded Track. The coal seen in the brook dips to the N. 15°, W. 15°. It is said to be in all this E. district not more than 8 feet thick, having lost its lower tier, or the two lower tiers having thinned down; while in this region the 5-feet or 7-feet Coal has 7 feet or even more of good coal in it.

Plainsville.—At Mr Swallow's house there is a coal 5 feet thick, with a N. dip, which was thought by Mr Williams to be the same which was mined near his store at the end of the lane at Plainsville. The same coal crops out on the road between his house and the Methodist Meeting-house, 70 feet S.E. of Mr Swallow's barn; he bored 80 feet through a slate rock, and reached a 7-feet coal: he did not go through the coal, and which coal-seam it is cannot be known.

There is a well-marked anticlinal passing under the Methodist Meeting-house on the Main Road. It bears S. 75° W., and ranges for the saddle seen in the brook on Maxwell's Railroad.

There are two anticlinals between this and Maxwell's Coal—one at Williams's house, and one S. of it, seen about 200 feet S. of Williams's store.

CHAPTER V.

WILKESBARRE, NANTICOKE, AND SHICKSHINNY DISTRICT.

BETWEEN Laurel Run, or Mill Creek, and the W. end of the coal-field at Shickshinny, the whole district S. of the Susquehanna constitutes one natural division of the Wyoming Basin, which may be appropriately designated as the Wilkesbarre, Nanticoke, and Shickshinny district.

It is remarkable for the great length and general parallelism of its included anticlinal and synclinal flexures; two or three extend almost continuously throughout its whole length, rendering it inconvenient for us to subdivide it, as we should, but for this, into an Eastern and Western sub-district. The anticlinals of this portion of the coal-field are approximately parallel with the S. boundary or outcrop of the general coal-basin, which, from Solomon's Gap to its intersection by the Susquehanna River below Shickshinny, is remarkably straight. Another general fact connected with the anticlinals and included basins pertaining to this district, is the difference in their general direction, comparing them with those of the Pittston group. We have already seen how these latter deviate by several degrees from strict parallelism with the axis-lines of the flexures of the Lackawanna, and we may now notice a like departure to a direction somewhat more E. and W. in the group of undulations before us. The average difference in range by compass between those of the Wilkesbarre and Nanticoke district, and those of the Pittston region, is not less than 7°.

Though the large district we are describing includes a considerable number of anticlinal undulations, as many as six prominent ones on an average, the whole district may be more conveniently and correctly viewed as made up of three leading troughs, or long undulated synclinal belts or basins, and two principal interposed anticlinal tracts. The most Northern of these, or Basin XVII. of the general enumeration, is that which is sometimes called the River Basin, or the synclinal zone which contains the borough of Wilkesbarre and the village of Nanticoke. The next or middle one, No. XVIII., is the long synclinal belt or basin which embraces the village of Newtown and that of Newport Centre; while the third or Southern general basin, or No. XIX., is that which lies next adjacent to the foot of the Little Mountain, the S. barrier of the coal-field.

We shall now proceed to a more detailed description of these several basins, with the subordinate anticlinal undulations which they contain, and to that of the anticlinal belts which divide them.

Synclinal Belt, or General Basin, No. XVII.—Observing the order adopted throughout our description of this coal-field, or that which takes us S. or S.W. across the valley, but Westward along each individual anticlinal and synclinal belt, the first zone which offers itself for detailed examination is that of Wilkesbarre and Nanticoke. This is bounded on its N. by the anticlinal No. XVI., separating it from the basin of Mill Creek, and also by the flats of the Susquehanna as far as the Nanticoke Notch, beyond which the River Mountain is its boundary. Its Southern limit is the chain of anticlinals called No. XVII., or that line of flexures which, bounding the mines of the Baltimore Company on the S., and ranging N. of Newtown, passes likewise N. of Newport Centre, and thence N. of the middle branch of the Nanticoke Creek.

Several seemingly independent anticlinal flexures, at least six in number, undulate more or less the strata embraced within this large and richly-stored sub-basin of the coal-field. A special definition of these, and of their effects upon the strata, is essential to a full understanding of the course and distribution of the coal-seams included in the basin. Commencing at its E. end, the first of these, as far as they are at present known, is—

Anticlinal A *of Basin* 17.—This is the obscurely-indicated anticlinal flexure which ranges centrally along the little valley extending from Laurel Run to the S.E. corner of the town-plot of Wilkesbarre, and which I have supposed to cross Coal Brook a few hundred feet N. of the Old Still-House coal opening, and to range through the summit of the low flat ridge, over which runs Judge Conyngham's Lane. No distinct outcrop of the strata exists to prove such a flexure, though its presence is strongly indicated in all the features of the surface, and in the fact that a low anticlinal flexure in this position is implied by the great breadth of North-dipping strata visible both to the S. and to the N. of it, implying a thicker sequence of the Coal-measures than on the hypothesis of no such axis we know to prevail within this neighbourhood. It is not possible to suggest, with any approach to certainty, the particular part of the Coal-measures which this axis brings out to the surface ; but as a hint, it may be useful to call attention to the possible identity of the Still-House Coal of Mr Butler's Meadow, stated to be 10 feet thick, with the Hollenback or 10-feet thick bed, next over the large Pittston Seam. It is upon the presence, indeed, of a bed of this alleged thickness, in this position, that I rest in part my inference of the existence of an anticlinal undulation running along the valley through the Butler and Conyngham farms.

Anticlinal B *of Basin* 17.—A little to the S. of the drift-covered plain, supporting the borough of Wilkesbarre, we detect the first well-developed anticlinal flexure in the basin, and we may trace it ranging along the brow of the hill next S. and S.W. of the town. Both of the dips of this arch are to be seen on the Easton Turnpike, and likewise on Market Street, where it leads up the hill. At these intersections it is about 1000 feet S.E. of the canal, and we encounter it again at nearly the same distance on the Tamaqua Turnpike. We again find the axis on the lane running Southward from the Middle Road, from a little W. of South Wilkesbarre, the centre of the arch a little more depressed and feeble, being about 600 feet S.E. of the Whitehaven Railroad. The flexure disappears to the W. of this point, under the superficial materials which cover the valley of Solomon's Creek, beyond which we detect no traces of it. Whether this gentle flexure prolongs itself any distance to the Eastward of Wilkesbarre, or exists there in any greater force than as a mere roll discernible only in mining, is very doubtful. To the N. of the Baltimore Company's Shaft it can exert but a trivial effect, if indeed it extends itself as far as the ravine of Coal Brook, for E. of this we meet with nothing but N. dips in the line of its prolongation.

Strata elevated by the Anticlinal B *of Basin* 17.—This anticlinal elevates to the surface a small coal-seam on the roads leading S.E. from Wilkesbarre, and the same coal, to all appearance, is brought by it to the day, both on the Tamaqua Turnpike and on the lane near the railroad. The coal of the two latter localities is certainly that which has been mined at South Wilkesbarre at the side of the Whitehaven Railroad, in the basin N. of the anticlinal. But this coal is evidently the same as that exposed near the Powder Mill at Quick's, and is that also of the small slope-mine one-third of a mile further W. ; and it is the same in all probability with Siveley's Coal, mined on the N. brow of the next large hill to the Westward, where the outcrop is only a few hundred feet S. of the crossing of the River Road over Solomon's Creek.

In our compilation of the Coal-measures, commencing with the conglomerate, as exposed in the Section from Solomon's Gap to this intersection of the Creek and River Road, we enumerate twelve workable coal-beds—the seam which we have now been tracing, being next to the uppermost, or the eleventh from the bottom. This anticlinal is situated only a few hundred feet S. of the main synclinal line of the River Basin.

Anticlinal C *of Basin* 17.—The next anticlinal of Basin 17, whose position is to be indicated, is one of apparently limited length, situated S. of the River Road, in the vicinity of the Green, or the Lutheran Church. The axis of this flexure may be detected on the lane leading S.E. from near the church, at the distance of about 800 feet from the River Road. The anticlinal structure at this point, and for half a mile Eastward along the ridge which the axis occupies, is distinctly marked in the features of the ground; its position is but a few hundred feet to the N. of the general synclinal axis of the basin.

An outcrop of a coal-seam is visible near this anticlinal axis, and is obviously one of the higher beds of the district, possibly the Siveley Coal itself. The dips on the flanks of this axis are all gentle; the S. ones, which are the most considerable, not exceeding 30°.

Anticlinal D *of Basin* 17, *or that of the Luthern Church at the Green.*—The anticlinal flexure now before us first shows itself on the River Road, or a little S. of it, near Dilley's, half a mile E. of the Green, being indicated on the road by a very gentle Northward dip in thin-bedded sandstones on the summit of the hill. From this point it ranges S.W., and passes almost immediately under the Lutheran Church, where the flexure is still a gentle one. The furthest point Westward at which it can be detected, is on Steele's Lane leading down from the road towards the river, where the N. dip does not exceed 5°.

This anticlinal lifts to the surface the Coal-measures next beneath the Siveley Coal-bed: but its influence as a subordinate undulation in the General Basin is very trivial.

Anticlinal E, *or that of the Nanticoke Mill.*—The next anticlinal flexure which we encounter in the River Basin, is one which may be seen rising Westward from beneath a covering of drift gravel, just W. of the Nanticoke Creek at the Nanticoke Mill. From this point Westward, its course, for a short distance, nearly coincides with that of the N. road at the foot of the River Mountain; but it soon leaves the road, and ranges forward for 2 miles, as a depressed undulation on the flank of the mountain, high on the Southern slope of which it loses itself in an indentation in its crest. Throughout its course, the dips belonging to this flexure are gentle, and its influence therefore in undulating the coal cannot be serious. At the Mill, the N. dip is only 10°, while the S. dip, as shown in the coal-beds, outcropping along the S. bank of the Nanticoke Creek, amounts to about 30°. At the intersection of this axis with the creek, the lowest coal-seam lifted to the surface appears to be the third in the series, though possibly it is the fourth above the thick lowermost bed of the basin, or that called Lee's, at Nanticoke. Still higher coals dip from this axis Southward, outcropping in succession along the Nanticoke Creek.

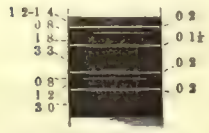


FIG. 282.—Lee's Coal, W. side of Nanticoke Gap.

The size and composition of Lee's valuable coal-bed is here shown. It is extensively mined on the W. side of the river at Nanticoke. The coal of its best benches is in much repute.

Anticlinal F *of Basin* 17, *or that N. of the Gruver Schoolhouse.*—The sixth anticlinal, and the next to be mentioned in the River Basin, lies between the preceding, at a distance of about

1100 feet from it and Nanticoke Creek. It originates in the hill next N. of the Creek, and at a little distance W. of the mouth of Lee's Creek, and is crossed by the N. road of the basin about 1¼ miles W. of the Nanticoke Mill, the very arch of the axis being well exposed where the road descends to cross a small brook. From this point it ranges forward N. of the Gruver Schoolhouse, obliquely ascending the flank of the River Mountain, until we lose the last traces of it in the large indentation in the crest of the mountain through which the road passes over from the Coalfield to the Susquehanna River. Like the preceding axis (axis E), the flexure before us is a gentle one, its N. dips especially being very feeble. Both of these probably merely flatten the South-dipping strata of the mountain along the W. half of their course; but their influence, nevertheless, must be sufficient to give a wide double sweep to the outcrops of the lower Coal-beds, especially to that of the great one which overlies the conglomerate.

Anticlinal G, *or that of the N. Branch of Nanticoke Creek.*—The last axis which we have to specify as occurring in the River Basin belongs to its Western extremity, or the valley of the N. Branch of Nanticoke Creek. The N. and S. dips, establishing the existence of this flexure, are to be seen on the road leading from Newport Centre to the Gruver Schoolhouse. The N. Branch of Nanticoke Creek seems to flow nearly on the back of the anticlinal for the lowest mile of its course. Westward from this the axis takes the hill S. of the road which leads over the mountain to the river. This anticlinal appears to be accompanied throughout by only gentle dips.

POSITION OF THE MAIN SYNCLINAL AXIS OF THE RIVER-BASIN.

A subordinate synclinal trough, the most North-eastern of the basin, ranges from the junction of Laurel Run with Mill Creek to the synclinal hill at the angle of the Canal, near its intersection with the Plank Road, crossing the Plank Road obliquely a little E. of the town-plot of Wilkesbarre. This basin includes perhaps the highest Coal-measures or Coal-seams anywhere to be met with in the River Basin; the upper bed on the Plank Road being the eighth of all dimensions, great and small, above the Wilcox or Pittston large seam, and the fourth or fifth of workable size. See the Section southward from the mouth of the Mill Creek.

The main synclinal axis of the general River Basin is not, however, the one above described, which vanishes, or is at least cut off at the river; but it is a much longer one, first discernible on the Susquehanna and Lehigh Railroad, just S. of South Wilkesbarre, and traceable thence across Solomon's Creek, and across Behe's and Butler's creeks, till we lose it S. of Nanticoke. The synclinal axis, or line of greatest depression of the basin, crosses Solomon's Creek only a few hundred feet S. of Quick's house on the River Road. It is marked by a depression in the hills midway between Inman's and Siveley's outcroppings of the upper coals, and passes a few hundred feet N. of Behe's Pond, and about as far S. of the Red Tavern. We thence trace it across Behe's Creek near the deep boring, and through the synclinal hill next S. of the River Road. Westward from this vicinity the keel-line of the basin is less distinctly traceable; it evidently approaches the S. side of the trough, being but a few hundred feet N. of the anticlinal boundary of the basin, Axis No. 17, on the farm of the late Solomon Fairchild. This displacement Southward is the consequence of a widening of the belt of gentle S. dip in the neighbourhood S. of Nanticoke, a widening which is due to the dying down Eastward of some of the oblique anticlinals of the River Mountain originating N. of Nanticoke Creek.

COAL-MEASURES CONTAINED IN THE RIVER-BASIN W. OF WILKESBARRE.

It has been already intimated that the highest Coal-bed embraced within the River Basin W. of Wilkesbarre, is that exposed at the level of the railroad near South Wilkesbarre, and that this is probably the twelfth or thirteenth in the ascending order of the whole series. A careful tracing of the outcrop of this coal-seam past Quick's house and the old slope N. of the Middle Road, and again on the S. side of the basin, leads me to the conclusion that it is the same bed opened by Siveley S. of the River Road, and visible again at Inman's on the Middle Road on the opposite or N. dip. This coal is probably lifted, or rather washed, out of the basin before it reaches Behe's Pond; for the whole trough must evidently be shallower in this neighbourhood than further Eastward in virtue of the lifting influence of the two saddles, especially the S. one in the vicinity of the Green. Still further Westward, or between Behe's Creek and Nanticoke Creek, the highest coals in the basin are probably on the horizon of that of South Wilkesbarre, or perhaps a little lower. The comparatively compressed condition of the leading anticlinal, No. 17, where it bounds this part of the basin, will probably compensate for the shoaling influence of anticlinals which enter the basin from the Westward at Nanticoke, and impart the depth I have assigned to it. To the Westward of Nanticoke the basin must evidently become rapidly exhausted of its upper coals. The bluff on the S. side of the Susquehanna, at and below the mouth of Solomon's Creek, contains a bed of coal 3 feet thick at its base at the level of tow-path, which belongs evidently to a high place in the series. It is probably the tenth or eleventh coal above the conglomerate.

Tracing this basin Eastward from Wilkesbarre across the valley of Laurel Run to the upper waters of Mill Creek, we find it impossible, in the present disguised condition of the surface and unopened state of the coal-beds, to indicate the particular parts of the Coal-measures which basin out, rising Eastward at those streams. If the large coal-bed of the Baltimore Company should prove to be identical with the so-called New Haven Bed, an upper bed of which is exposed at the water-level of Mill Creek precisely on the axis of anticlinal No. 16, then indeed there will be some data for tracing this great bed of coal Eastward from that meridian in the basin before us,—that is to say, to some point higher up Mill Creek; but this sometimes asserted identity of the two coals is at present wholly without proof, for at the anticlinal exposure of the New Haven Bed no more than a 6-feet thickness of coal is exposed to view,—the statement of its being a much thicker seam resting only on rumour. It may possibly, however, be the Baltimore Company's bed, if it really does possess the alleged size of 11 feet, and if there occurs a flat anticlinal in the basin between this New Haven opening and the Easternmost tracing of the Baltimore Company's outcrop on Laurel Run. Not pretending to conjecture what the true state of things may be, I content myself with throwing out these hints for the guidance of those who may wish to pursue the exploration. I must observe, however, that I have traced the Baltimore Company's Coal from the Old Mine to Laurel Run, and thence more vaguely E. 15° N. to a point half a mile S. of the coal on Mill Creek, and have come to the conclusion that the coal on Mill Creek at New Haven is not the Baltimore Coal, but a higher one.

There is probably an axis S. of the outcrop of the Baltimore Company's Coal on Mill Creek, the effect of which must be to swing it round and place the next North-dipping outcrop considerably further N. when we trace it Eastward, and such must be its position on Thomas's

Land or Gardner's Creek. But even this will not bring it out to the level of the New Haven Coal.

Anticlinal Belt No. XVII.—The S. limit of the broad and deep river-basin which I have been describing, is formed rather by a chain of three anticlinal axes than by one continuous wave. The middle and Western links of this chain are very possibly one axis ; though unable at present to trace them into each other, I abstain from pronouncing on their identity, notwithstanding their lying nearly in one line. Between the Eastern and middle links, on the contrary, there is no such seeming connection ; the E. axis, that of the Baltimore Company's Old Mine, lying several hundred feet to the S. of the prolongation of the middle axis, or that seen at the junction of Market Street and the Eastern Turnpike. Tracing these three segments of the anticlinal belt severally, I commence with that which is most East.

Anticlinal No. XVII. *East, or that of the Baltimore Company's Old Mine.*—This anticlinal axis, the most Southern well-developed flexure of the district S. of Laurel Run, is distinctly discernible on both sides of that stream, about two miles above its mouth, and about half a mile N. of the outcropping of the Seral conglomerate in the bed of the stream. From the point thus indicated, the axis pursues a straight course W. along the S. side of the broad hill which carries the outcrop of the Baltimore Company's great bed, at its N. base, to the open workings of the old mine. At this last-named spot the very summit of the anticlinal wave is visible in the arching of the bottom slates of the great coal-bed, where the upper stream of Coal Brook crosses it. To the W. of this point, the coal-bed, here naked at the axis, is quickly saddled over by its covering strata, and the gradual subsidence of the anticlinal in that direction places the summit of the wave in the coal at a lower and lower level as it runs on and enters the mines and lands of the Black Diamond Company. It is impossible to say at present how far in the same direction this flexure actually prolongs itself ; but as the mining in its vicinity is actively advancing, the day is not remote when its W. limit will be known.

There are several subordinate rolls or trivial flexures on the N. slope of this main anticlinal of the Baltimore Company's basin ; but these, though they disturb to a small extent the working of the coal, are practically too unimportant to demand any specific notice.

This axis is nowhere one of steep curvature of the strata. Its S. dips are very gentle, being nearly flat, and its N. dips, or those into the river or Baltimore Company's basin, nowhere exceed 30°. In the old mine at the outcrop, the dip is much less than this, in but few places exceeding 10° or 15°.

Coals lifted out by the Axis.—Of the coals elevated to the surface by this anticlinal, little need be added to the statement already made respecting the outcropping of the great Baltimore seam just at the axis S. of the old mine. With the W. dip of the anticlinal, the next higher coals saddle it under cover as it declines before leaving the Baltimore Company's land, and these superior coal-beds are cut in that Company's shaft on the N. slope of the anticlinal wave. They will be more specially described in our account of this colliery.

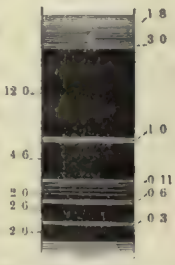


Fig. 283.—Baltimore Bed at Old Mine, S.E. of Wilkesbarre.

The great *Baltimore Bed* is mined—

1. At the Wilkesbarre Company's new mines by a slope on its N. dip.

2. At the Wilkesbarre Company's old mines (the Blackman Mines) on the N. dip of a second basin N. of the mountain, where it is worked by a slope.

3. It *has* been worked by Maffit by drifts, and a slope at the bed of a creek about 1000 feet E. of the Wilkesbarre old mines, where the N. dip is very gentle.

4. By Laning in numerous water-level drifts, S.E. of Wilkesbarre, about 1¼ miles E. of the Easton Turnpike, where the dip is N.

5. At the Black Diamond Colliery in a tunnel or shaft, &c. S. of Wilkesbarre, and also by Mordecai at the same place.

6. By the Baltimore Company at their mines in a tunnel, shaft, and in numerous drifts and open cuts.—(See the Frontispiece to this volume; also the interior view of the Baltimore Company's Old Mine.)

Anticlinal No. XVII. *Middle, or that S. of Behe's Pond.*—We come now to the middle link of the belt bounding the river-basin. It is a leading anticlinal of very considerable length, and manifests itself quite conspicuously in the features of the surface. It follows the N. brow and sometimes the crest of the broad belt of hills which separates the immediate plane of Wilkesbarre from the valley of the E. Branch of Solomon's Creek, crossing which it ranges in a very nearly straight course to the valley of Behe's Creek, a little S. of Behe's Pond. W. of this last intersection, we fail to trace it for a mile or more across the E. branch of Butler's Creek, notwithstanding its coincidence in direction with an axis which appears W. of the further of those streams, and which I have designated Anticlinal No. XVII. W. The probability is, that the two axes are one and continuous, and that a slight curve in their course is all that breaks their strictly linear prolongation; but the disguised state of the surface, due to a deep covering of drift, frustrates every attempt at actually tracing their connection, which only mining can bring to light. To define the middle axis more closely: It is seen in full development on the lane leading from the Tamaqua Turnpike to S. Wilkesbarre, about 600 feet N.W. of the turnpike; it passes the turnpike itself just S. of the elbow which this makes near the new brick building, E. of which we may follow it in a straight course till we detect its dips in the brow of the hill at the descent of the Easton Turnpike, a little N. of the junction of this with Market Street in Wilkesbarre. It probably ceases within half a mile E. of the Easton Road, for we find no evidences of it to the N. of the Black Diamond shaft, in the position which it ought to occupy.

W. of the lane where we first took it up, it manifests itself in the summit of the large swelling hill which points down towards Solomon's Creek, near the mouth of its E. branch, and we may recognise the flexure again in the lane beyond this creek leading N. from Solomon's Gap. The anticlinal is next well exposed on the middle or Newport Road, near the mouth of the next lane leading S. to the Back Road. In this neighbourhood the effects of the carving of the surface by powerful denuding waters, is conspicuously seen on the two flanks of the axis, in a double line of escarpments or sharp sandstone ledges. We may again detect the passage of the axis on the next lane to the W., or that which leads N. from Downing's, on the Newport Road, to the green on the River Road; and we catch its two dips once more to the S. of Behe's Pond, in the two hills which bound the smooth little anticlinal valley, situated a few hundred feet to the S.W. of that sheet of water. Beyond this we lose it under the deep covering of drift which conceals the strata both E. and W. of Butler's Creek. But almost in the same line we detect, as we approach the S. Branch of Butler's Creek, an anticlinal dipping of the rocks continuously traceable into the long straight axis, or portion of this same axis, which has been entitled No. 17 W.

Throughout its course, from the Turnpike S. of Wilkesbarre to the vicinity of Behe's Pond, this straight and regular anticlinal is distinguished by comparatively gentle dips; the N. ones,

INTERIOR OF BALTIMORE CO^S OLD MINE, WILKES BARRE

near the arch, not exceeding 10° or 15°, and the S. ones nowhere surpassing about 25° or 30°.

A 7-feet coal-bed has been penetrated in a well near the axis on a N. dip near the N. end of the straight street leading out from Wilkesbarre to the Easton Road, and a bed probably the same has been partially explored, on or very near the axis on Mr Ross's farm, near the S. brow of the Hill, in a direction nearly W. of the Schoolhouse. That this coal holds a high place in the series is very obvious from the relation of this axis to the outcrop of the Baltimore Vein. It is very probably the 10th Coal of the Solomon's Creek group—that, namely, which outcrops in the bed of Sugar Creek, a little above its mouth.

On the Whitehaven Turnpike the measures exposed on this axis appear to be those which separate this 10th Coal, which is not there brought out to day, from the overlying 11th, or that of the Basin next to Wilkesbarre. We meet with the same 11th Coal on the lane leading from Solomon's Gap, N.W. to the River Road; it is parted into two outcrops at this anticlinal, the more Northern one being just on the brow of the steep South-sloping hill facing Solomon's Creek. What the coal is, which this axis causes to outcrop on the Middle Road W. of Inman's, is a question we have not yet solved; but it is probably the 11th, or a still higher seam.

Within the basin lying N. of the anticlinal thus described, there occurs in the Whitehaven Turnpike a small subordinate flexure about 500 feet from it, which lifts out the coal which we have designated as the 11th, and seems not to place it back again under any cover of strata before the main axis elevates rocks which are yet a little lower in the series. The range of this feeble flexure E. and W. seems to be very limited.

Strata exposed along the Anticlinal.—The rocks and coal-beds lifted to the surface and denuded along this anticlinal axis are manifestly those which next overlie the Baltimore Company's great vein; in other words, they constitute the group next beneath the S. Wilkesbarre series. The reader will inspect advantageously the cross sections (Plate V.) which show this axis on the Easton Turnpike, and again on the lane leading N. from Solomon's Gap. N. of the Baltimore Company's main anticlinal, the whole way to the Back Road, we encounter no reversal of the dip in the district E. of Coal Brook; and in this space we recognise, as overlying the Baltimore Bed, three or perhaps four other coals of lesser size: two of these are known coals, visible at the Baltimore Company's Shaft. It is plain, therefore, that neither Anticlinal XVII. Middle, nor the little flexure N. of it, have any existence so far towards the E.

Anticlinal No. XVII., *W.*—As already intimated, this anticlinal—a probable prolongation of that just described—shows itself first a little E. of the S. Branch of Butler's Creek, crossing which, we may trace it in the topography, and likewise by occasional visible dips, to Fairchild's Lane, or that S. of Nanticoke, where the axis is well exposed close to the right-angled turn or offset in the lane. Beyond this point we lose it for half a mile as it passes the valley of Lee's Creek, but we meet it again N. of the Nanticoke and Newport Centre Road, and may trace it thence for at least three miles continuously, until it flattens away high on the S. slope of the River Mountain. In this Western part of its course it runs just at the Northern base of the hill or table-land, N.W. of Newport Centre, and, crossing the middle Nanticoke Creek, it follows the N. side of the same hill, prolonged till it enters the narrow valley occupied by the Southern tributaries of the N. Nanticoke Stream, beyond which we soon lose it in the Mountain.

The anticlinal, or section of the Anticlinal No. XVII., is characterised by a considerably greater steepness in its two sets of dips, than belongs to the middle section. Near the S. Branch

of Butler's Creek both dips amount to 40°; at Fairchild's Lane, the N. dip is 40° and the S. 30°. E. of Newport Centre the S. dip is again 40°; but W. of this point it flattens to an average inclination of 20°—while the N. dip increases until, in the district between the North and Middle branches of Nanticoke Creek, it amounts in some places to a steepness of 70°.

Strata brought to light along this Axis.—Almost nothing has been done to develop the coal along the line of this anticlinal, and I can only be guided by general considerations in stating what Coal-measures the axis appears to elevate to the surface; nevertheless, a careful study of the ground from the N. side of the river basin to this axis on Fairchild's Lane, on the Nanticoke and Newport Road, and in Nanticoke Creek, has satisfied me that the saddle, in that vicinity at least, throws out none but Coal-measures very high in the series. In proof of this I would appeal to the very long succession of South-dipping strata, extending from Lee's large mine to within a very few hundred feet of the axis; to the extensive sequence of coals embraced in those strata, and to the narrowness and comparative flatness of the anticlinal, wherever it is exposed in this quarter. W. of Newport Centre the rise of the anticlinal line, and the general lifting up of the whole coalfield, causes a rather rapid cutting out of the strata in the line of the axis; but as it runs for nearly four miles from Fairchild's Lane to where it flattens in the flank of the mountain, it is obvious that there is ample space for a gradual throwing out of a thick succession of Coal-measures.

Basin No. XVIII. *and its Undulations.*—We pass now to the *middle* synclinal belt of the Wilkesbarre, Nanticoke, and Shickshinny District. This is not a simple trough, but in every part of its length it is undulated by one or more anticlinal waves. Its N. boundary is, of course, the anticlinal belt No. XVII, which we have just been tracing. Its S. boundary, or that which divides it from the basin at the foot of the mountain, is another broken line of anticlinal elevations of the strata, consisting of two main anticlinals, which are approximately in line with each other; the Eastern one indicated on the map as Axis No. XIX. E.; the more Western one as Axis No. XIX. W. The more precise description of these bounding anticlinals is reserved for the next division of this Chapter, our present topic being the structure of Basin 18, its undulations, and its Coal-measures.

Course of the Synclinal Axis of Basin No. XVIII.—Commencing with its Eastern end, we take up this Basin in the neighbourhood of Laurel Run, between the Mountain and Anticlinal No. XVII. E.; and following the valley Westward, we find ourselves behind, or S. of the Baltimore Company's Old Mine and axis, in the E. end of a wide shallow trough of the Big Baltimore Coal-bed. Pursuing the centre of this trough Westward, it takes us across the Easton Turnpike a little N. of where this crosses the East Branch of Solomon's Creek, and carries us over the Tamaqua Road about the same short distance S. of the same stream, or past the N. edge of the village of Newtown. The synclinal keel of the basin next crosses Solomon's Creek, several hundred feet N. of the mouth of Sugar Creek, being visible on the lane leading N.W. towards the canal. Following it through the hills, we meet it distinctly shown in the dipping of the strata on the next cross-road; and further forward we find it on the main Newport Road, in the neighbourhood of Ruggle's Creek. Once more we detect it on the cross-lane which passes by Behe's Pond, where it ranges about 600 feet to the N. of the Newport Road. Again we meet it crossing both branches of Butler's Creek, 800 or 900 feet N. of the Newport Road, and we find it on Fairchild's Lane, leading to Nanticoke, some 1200 feet from the road. W. of this,

after crossing Lee's Creek, the synclinal belt of the basin divides or forks in consequence of the introduction of a W. anticlinal axis—anticlinal of basin 18; and the synclinal line most nearly in prolongation of that we have been tracing, runs on crossing the Dodson Schoolhouse Lane, some 1300 feet S. of the Newport Road, beyond which it gradually fades, until it ceases to be traceable beyond half a mile W. of Newport Centre. It does not reach Vendermark's Hill; but another synclinal line or basin 200 or 300 feet S. of it in position, commencing S.W. of Newport Centre, passes through the hollow of that hill, and a little N. of Fitzgerald's Corner.

The S. Branch of the synclinal, taking this up W. of Fairchild's Lane, crosses the Dodson Schoolhouse Lane about 1200 feet N. of the S. Newport Road, and from this point may be followed along the hills and across the lanes which go N. over them, till we meet it in the point of the spur-shaped Hill, intersected by the S. Branch of Nanticoke Creek, where it turns N. Thence it follows the summit of this ridge, which distinctly exhibits the basin structure nearly as far W. as the lane leading S. from Sorber's.

Strata embraced in the Central or Synclinal Portion of Basin No. 18.—We have seen that just S. of the Baltimore Company's old mine, this basin lifts out that part of the Coal-measures which includes the great Baltimore Bed. From this point W. as far as the Baltimore Bed, it retains its integrity, though at what distance it breaks up or loses this is not at present ascertainable; the basin carries that coal-seam, and the group of coals next over it. It is quite obvious that in the vicinity of Solomon's Creek, and, indeed, throughout its course, probably as far as Lee's Branch of Nanticoke Creek, the Coal-measures in the centre of this trough are identical, or nearly so, with those in the deeper part of the river-basin W. of Wilkesbarre. Possibly the highest coals retained are one or two beds lower in the series than the S. Wilkesbarre or Siveley Seam. Approaching the W. waters of Nanticoke Creek, the basin forking begins to throw out the middle Coal-measure; and towards the W. end of the coal-field, as at Sorber's and further W., it can include only the lowest division of the coal-bearing strata.

The following section, which was communicated to us just before going to press, represents the strata cut by a shaft upon the lands of the Audenried Improvement Company, about a mile S. of Wilkesbarre, and within the basin we have been describing. Comparison with the general section of the strata at Wilkesbarre (page 322), which was compiled from numerous local measurements, may be interesting to show change of type, and thickness of the coal-seams and included rocks. The dip at the shaft is 11° S.

Earth and sand, 16 feet; sandstone, 40 feet; slate, 14 feet.
Coal, 10 feet; slate, 40 feet.
Coal, 6 inches; slate, 40 feet.
Coal, 6 feet; fire-clay, 10 feet; slate, 50 feet.
Coal, 1 foot 8 inches; fire-clay, 10 feet; micaceous sandstone, 21 feet; slate, 5 feet.
Coal, 5 feet; fire-clay and slate, 27 feet; micaceous sandstone, 32 feet.
Coal (Baltimore bed?), 7 feet; fire-clay, 3 feet; black rock, 57 feet.
Coal, 5 feet; micaceous sandstone, 15 feet.

A drill hole, extended 38 feet below the bottom of the shaft, cut two thin seams of coal.

Anticlinals included in Basin No. 18.—There are at least seven independent anticlinal flexures of the strata detected by me in the general synclinal belt, all of them exerting an

important influence in the distribution of the coal, and destined to control, more or less, all the future mining operations within their neighbourhood. I proceed to trace these in detail.

Anticlinal A *of Basin* 18.—The first or most Eastern anticlinal which we encounter lies S. of the main synclinal tract of the Basin, at a distance of not more than 1200 feet N. of the leading anticlinal No. XIX. E. It is a comparatively gentle flexure, originating W. of the Easton Turnpike, passing between the N. of the three sub-basins of the Wilkesbarre Company's mine and the Baltimore or main basin N. of them, and crossing that Company's lane at the White House and the Tamaqua Turnpike, a thousand feet S. of the village of Newtown. We lose this axis for a distance of about one-third of a mile as it passes under the drift-covered valley of Solomon's and Sugar creeks; but we recover it again W. of Sugar Creek, dividing two escarpments in the hill, which extends thence towards Miller's late residence on the cross-road next W.; but in this vicinity the strata are much obscured by drift, even on the summits of the hills, and it is impossible to trace the axis even up to that cross-road. The indications are, that it ceases E. of it.

This anticlinal appears to be one of rather gentle flexure throughout the E. half of its length, where it passes through the Wilkesbarre Company's lands; but W. of Sugar Creek its N. dips are very steep. Its S. dips are everywhere the gentlest.

Strata visible near the Axis.—Like the Anticlinals Nos. XVII. and XIX. adjoining it, this flexure seems to come off obliquely from the base or flank of the S. or Little Wilkesbarre Mountain, and to decline in level as it ranges W. In virtue of this subsidence, it is gradually in its progress overarched by higher and higher coals. *First,* The Great Baltimore Bed saddles the axis just E. of the Wilkesbarre Company's mines, and is under a good covering of strata from this point of its saddling W. South of Newtown, one of the lower of the middle group of coals, or of the set next over the Baltimore Bed, laps over the axis near the Tamaqua Turnpike, and a coal, probably the same in the series, which was opened just N. of Sugar Creek, above its mouth, closes over the axis a few hundred yards still further W. This is one of two coals below the Newtown Bed, and is probably about the third below the S. Wilkesbarre seam, or Siveley's. The basin made by this axis A and the main axis, No. XIX. E., will be spoken of in our description of this last-named anticlinal.

Anticlinal B *of Basin* 18.—Next in position W., is a still feebler and shorter anticlinal flexure, probably not more than a mile and a half in length, lying also to the S. of the main synclinal axis of the Basin. Our first clear recognition of this feeble wave in the strata is on the cross-road running S. from near Inman's to the S. back road, only 300 or 400 feet N. of J. Miller's old residence. From this point W. it is much obscured by drift, but we recover it again S. of the main Newport Road, in the first hill S. of Ruggle's Creek, and may detect it crossing this road quite obliquely, just at the schoolhouse on the summit of the hill. From this point of intersection we can trace it gradually flattening and fading, for about one-fourth of a mile, when it disappears almost directly in the general synclinal line of the basin. At the next series of exposures, namely, on the lane just W. of Behe's Creek, we have the fullest evidence that it has disappeared.

Throughout its course, this flexure is a very flat or gentle one, yet it may probably influence the future mining of the district sufficiently to make this notice of it important.

Strata exposed near this Anticlinal.—It is in the vicinity of this anticlinal of the School-

house, but in the basin N. of it, or in the main synclinal, that a Red-Ash coal-bed, 6 feet thick, has been opened, and mined to some extent on the lands of John Hoover. This coal evidently occupies a high position in the series, and its proximity to the little anticlinal proves how trivial the effect of this latter has been in causing the denudation of the upper Coal-measures.

Anticlinal C *of Basin* 18.—The third anticlinal in this basin going W., is a very regular and straight one, running nearly parallel with the Middle or Newport Road, at a short distance S. of it, from Behe's Creek to the mouth of Fairchild's Road, leading N. to Nanticoke. Its length, from its E. point of origin, which is just E. of Behe's Creek, to the spot where we lose it N. of A. Line's, is about 3 miles; and its average distance from the main Anticlinal XIX. W., which lies S. of it, and makes with it a regular subordinate basin, is from 1000 to 1100 feet. This axis is accompanied along its E. half by unusually steep dips; but towards its W. termination the flexure becomes gentler, and the inclination of the rocks near it does not exceed 30°. It ends E. in a mere twitch or steep rumple in the broad belt of steeply North-dipping strata thrown off by Axis XIX. W.; but W. it appears to expire in the more usual manner by gradually flattening down. Throughout its course the axis may be readily traced by the marked impression of the anticlinal arching of the strata, upon the topography or the configuration of the surface.

Very little can be stated specifically in regard to the coal-beds which this anticlinal lifts and exposes at the surface, further than that they are those which lie next subjacent to the high Red-Ash seams before spoken of as opened on John Hoover's land, near the Schoolhouse on the Middle Road. They belong, therefore, to that division of the Coal-measures which is so generally lifted to the surface by the anticlinals which lie centrally in the Wilkesbarre and Nanticoke District, or which, in other words, traverse the chain of hills called the Hog Back—coals which I have designated as the middle group of the series, above the large lower White-Ash beds of the border of the basin, but beneath the two or three highest seams, which only occur in the synclinal knobs and table-lands.

Anticlinal D *of Basin* 18, *or that of Newport Centre.*—We come next in order to a much more conspicuous anticlinal wave. This, indeed, in the more central part of its course, is a double or complex flexure, and there, in the vicinity of Newport Centre, it is accompanied by very steep and abrupt dips, and apparently by some dislocation of the rocks. We first detect this anticlinal as a single and rather gentle flexure, on the cross road running S. from Nanticoke, only a few hundred feet N. of the late Solomon Fairchild's private lane; but the undulation displays itself in more complex and prominent features as it approaches Newport Centre, especially where it is crossed by the Dodson Schoolhouse Lane, and by the Nanticoke and Newport Road. Beyond the little village of Newport, the S. axis, or that of Fairchild's Farm, seems to disappear in descending Foster's Hollow, towards Hollenback's old mill; while the N. flexure, crossing just N. of the village, runs on to take the S. brow of the hill next N. of the Middle Nanticoke Creek, and in this line of prolongation it finally flattens away somewhere on the slope of the River Mountain.

A third much feebler flexure accompanies these two axes of this compound anticlinal wave, at a distance of some 300 feet S. of the Southernmost of the two chief axes of this compound anticlinal at Newport Centre.

On the Dodson Schoolhouse Lane, and near Newport village, the S. dips of the Southern of the two axes, and the N. dips of the Northern, are extremely steep; while the basin, not more than 200 or 300 feet broad, which divides them, is in the same proportion flat or shallow.

Strata exposed by the Anticlinal.—Two or three coal-openings occur adjacent to this anticlinal on the W., especially those of Newport Centre. One of these is on the S. side of the axis N. of the middle branch of Nanticoke Creek, and nearly opposite Fitzgerald's Corner; but what place in the series this or the other coals occupy, it is not possible, in the present undeveloped state of the district, to ascertain.

Anticlinal E *of Basin* 18, *or that of the Fitzgerald's Schoolhouse.*—Another anticlinal flexure of considerable length, possibly as long as the preceding, ranges along the S. side of the general Basin, No. 18, in a direction not strictly parallel to the bounding Axis, No. XIX. W., but converging gently towards it on going W. This axis, throughout the central part of its range, especially near to where it is intersected by the S. Branch of Nanticoke Creek, or S. of Vendermark's Mill, is characterised by very steep dips, both legs of the arch dipping at as high an angle as 80°, and exposing bold ribs of the coarse conglomeritic sandstones in those points where the softer strata have been most denuded. We first take up this axis on the road running S.W. from Newport Centre to the Methodist Meeting-house, about midway between those two points. Here the N. dip is but 5°, and the S. dip 20°. Tracing the axis to the cross road next E. of S. Nanticoke Creek, we can follow it thence along the valley of a Northern tributary of that stream at the N. foot of the hill, till it passes a little N. of the Fitzgerald Schoolhouse, beyond which, as it approaches the lane running S. from Sorber's, the dips and impression of the axis on the topography become less distinct.

Strata exposed.—Besides the bold ribs of conglomeritic sandstone developed at this axis, two or three outcrops of coal are visible near it; but I cannot say precisely what beds these are, nor can any one determine till the region is more explored by mining. They are evidently, however, members of the middle coal series of the basin.

Anticlinal F *of Basin* 18.—Far W. in the basin, and nearly centrally placed in it as respects its bounding anticlinals, is a gentle flexure some 2 miles or more in length, running from the valley of the middle branch of Nanticoke a few hundred feet N. of George Sorber's house, and thence to the very head of the S. Branch of Nanticoke, or the water-shed between that stream and the N. Branch of Black Creek, a point immediately N. of the road through the basin. A small coal-seam 2 or 3 feet thick has been opened on the S. dip of this axis, a little S. of the road near the water-shed here mentioned.

Wherever the dips belonging to this flexure have been detected, they do not exceed 15° or 20°.

Anticlinal G *of Basin* 18.—About 1400 feet N. of Sorber's, and therefore some 700 or 800 feet N. of Axis E, occurs another, which we call G. This is apparently a short flexure, and is too obscure and unimportant to merit a closer tracing.

Anticlinal H *of Basin* 18.—In the W. extremity of the basin there is another short anticlinal lying about 700 feet N. of the coal-drift, known as Colt's Coal. It is in fact this arch which contains Colt's coal, which, at the drift mouth, dips as gently as 5° S., and this would seem to be the flatness of the S. side of this axis generally. On the N. side of the anticlinal the dips are steeper, being as much as 25°.

The coal called Colt's probably emerges to the day nearer to the axis than at the spot where it has been mined; but at that point the bed has been entered by a lower or valley outcrop, the result of denudation, leaving a perpendicular cliff of sandstone, at the base of which the coal appears dipping with the slope of the hill.

Anticlinal Range, No. XIX., *or that separating Basin* 18 *from Basin* 19.—It has been already stated that this anticlinal belt consists of two principal flexures, the E. one designated as No. XIX. E., and the W. as No. XIX. W., and that these are separated in the middle part of the belt by a blank space, where neither is at present visible. Let us now define them with more precision, and indicate their effects upon the strata.

No. XIX. *East.*—Our first clear indications of this axis are at its intersection with the Easton Turnpike, which it crosses only a few hundred feet N. of the Toll-gate, and N. of the foot of the mountain. E. of this point it is too imperfectly traceable at present to admit of delineation; but W. we may follow it in a chain of anticlinals so nearly in its prolongation as fitly to be considered one with it for a distance of some 3 miles, or to a point half a mile W. of Sugar Creek. The Toll-gate Saddle or E. division of the axis is traceable to the Wilkesbarre Company's mines, where it is the axis which separates their middle or smallest basin from the third or N. one of those which the company is now working, or the axis upon which the underground steam-engine is seated.

Directly in the line of the anticlinal is a beautifully exposed flexure, in a cut of the Lehigh and Susquehanna Railroad, at the foot of plane No. 3, at Solomon's Gap; and this flexure I am disposed to consider identical with that just mentioned, as dividing the Wilkesbarre Company's second and third basins. This axis of the foot of the plane we can again recognise half a mile W. of Solomon's Creek, in the sharp sandstone crests of the hills, at a distance of about 1500 feet N. of where Sugar Creek intersects the Back Road; but approaching the cross-road next W., we fail to trace the further progress of the anticlinal for some distance, in consequence of the broad sheet of drift which there conceals all the outcrops of the rocks. We must pass, in fact, a blank space of more than a mile and a half, before we gain unequivocal traces of the anticlinal which lies nearly in its prolongation, and which is designated No. XIX. West.

The amount of flexure in this anticlinal wave is nowhere very steep in its E. portion; but in the vicinity of Solomon's Creek, and W. of Sugar Creek, the arching is much greater. On the Easton Turnpike at the toll-gate, the dips are very gentle, and they continue thus to the Wilkesbarre Company's mines; but at the foot of plane No. 3, at Solomon's Gap, the S. dip is as steep as 45°, while the N. leg of the arch inclines at 60°.

Coal exposed along this Anticlinal.—At the Easton Turnpike this flexure just lifts to the surface the rocks which next underlie the Little Toll-Gate seam, or the second coal below the Great Baltimore Bed; but the W. subsidence of the axis-line permits higher strata successively to oversaddle it, until, at the Wilkesbarre Company's workings, the Baltimore seam itself closes over it, passing out from the second or N. Branch of Basin 19 into the third or S. trough of Basin 18; and again by the continuance of this W. subsidence, still higher coals in the series—namely, the 10-feet and 4-feet, or the second and third coals above the Baltimore Bed—are per-

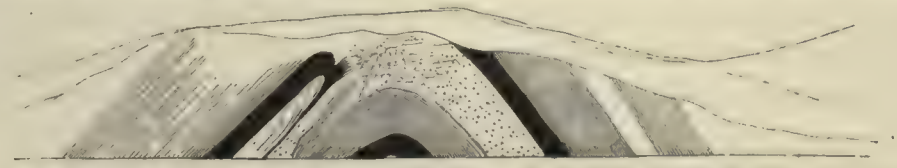


FIG. 284.—Section of Anticlinal Flexure No. XIX., near the foot of the lower inclined plane, Solomon's Gap, looking W.

mitted to arch themselves at the axis. These are beautifully exposed in the regular anticlinal

arch of the railroad cut, near the foot of the plane. (See our illustration of this cut, Fig. 284.) To the W. of Sugar Creek a coal still above these shows itself outcropping under the sandstone crests which there border the anticlinal axis.

At the arching of the coals in the railroad cut we behold a curious fault, with redoubling of the Second Coal, implying a N. sliding of the strata while in the act of bending. (See Fig. 284.)

Anticlinal No. XIX. *West, or that of the Dodson Schoolhouse and S. Nanticoke Creek.*—We have now to consider by far the longest continuous division of this anticlinal range. The first exhibition of this remarkably straight axis is to be met with a short distance W. of Behe's Creek, on the lane leading from the Middle to the Back Road, which it crosses about one-fourth of a mile N. of the latter. Crossing Leuder Creek, we trace this axis thence continuously through Leuder's Hill and across his lane, and meet it again on the Leutze Gap Road, a few hundred feet N. of the thick Stiver Coal-bed; thence we follow it to the Dodson Schoolhouse, and beyond this, by the base of the bluff hill N. of the main road, until it obliquely enters this hill, and stretches on to the S. Branch of Nanticoke Creek. In this part of its course it crosses the lane leading from the S. road up to Newport Centre, at a distance of some 1200 feet N. of the main S. road; and we detect it again just N. of the new Methodist Meeting-house, from which point we trace it readily, by the features of the surface, to the intersection of the middle road of the valley, with the S. Branch of Nanticoke Creek, and can follow it thence up the narrow valley of that stream to where this is crossed by the lane leading S. from Sorber's. We may pursue it, indeed, still further W., through the broad flat hill S.W. of Sorber's, to a knob which fronts the N. Branch of Black Creek, nearly opposite the outcrop of the large coal-seam known as Colt's. In all this course of about 9 miles, this axis observes an extraordinary straightness and regularity. It is a flexure of the normal type; that is to say, its S. dips are gentler than its N. ones, these latter being remarkably steep, especially between Leuder Creek and the Dodson Schoolhouse.

Strata elevated by this Anticlinal.—No very positive data at present exist for ascertaining precisely what division of the coal-series is brought to the surface by this axis in the different portions of its length; but the carefully-measured section near Leuder Creek, and other systematic explorations in the vicinity, lead me to the inference that, in this E. part of its course at least, it fails to lift out any but the highest coals of the district. There are probably at least twelve coal-beds beneath the saddle where it crosses Leuder Creek; nor do I suppose that this *suite* of coals is much reduced until we approach the Stiver opening, which, being a coal of unusual magnitude, is probably somewhere near the horizon of the Baltimore Bed, or five or six coals above the bottom. Approaching the S. Branch of Nanticoke Creek, probably still lower coals throw themselves out, though the flattening of the axis in its W. range, and its slight retreat from the S. edge of the coal-field, may compensate for the general Westward rise of all the strata. It is therefore quite possible that the large bed called Colt's is on the same horizon with the thick Stiver seam.

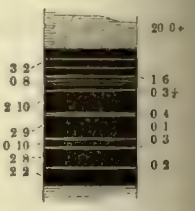


Fig. 285.—Stiver's Bed.

In the annexed woodcut the reader has a representation of the characters and dimensions of the Stiver Coal.

Basin No. 19, *or that of the N. Foot of the Little Mountain.*—This, the third, or most Southern

large synclinal trough of the district, is a very straight belt of Coal-measures, undulated, however, by a number of anticlinal waves, disturbing the distribution of its coal-beds from that perfect symmetry of flexure which they would otherwise possess. So numerous are these intruding anticlinal waves,—with nine or ten of which we are already acquainted, while probably several others of lesser magnitude remain undeveloped,—that it would be fruitless to attempt at this time any tracing of a general synclinal axis centrally along the belt; nor is it probable, indeed, that such exists. It must suffice, therefore, in attempting to exhibit all that has been brought to light respecting the structure of this tract, to indicate the anticlinals which it contains, and the effects which these may be judged to have upon the outcropping and distribution of the coal-beds.

Anticlinal A, *Basin* 19, *or that of Solomon's Gap.*—To commence as usual with the most Eastward in the basin. This subordinate flexure, traceable for perhaps a mile in length, crosses Plane No. 3 in Solomon's Gap, two-fifths of the length of the plane above its base. Here the flexure is well exposed in a cutting on the plane, and is visible, though more obscurely, on the turnpike adjoining the railroad. Half a mile to the Westward we detect it S. of Preston's house in an old excavation.

The strata lifted by this axis on the Railroad Plane are those immediately overlying the complex lowest large coal-bed or group of coal-seams, called the 19-feet bed, only the highest layer of which indeed is laid naked by it.

This axis appears to decline gently to the Westward, and it is probable, though by no means certain, that the coal-beds affected by it at Preston's are those next above the complex 19-feet seam.

Adjacent to this flexure, and a little S. of it, is another shorter and feebler one, discernible as a roll in Ross's Mine on Solomon's Creek; but this makes no external impression, and is probably of very local influence.

Anticlinal B, *Basin* 19.—Next in our progress Westward is a very long but rather gentle anticlinal flexure, commencing near Sugar Creek, and extending beyond the Western tributary of Behe's Creek. It ranges parallel with the foot of the mountain, diverging slightly from it Westward. The position of this axis for a greater part of its length is 900 or 1000 feet S. of the Back Road. It is seen in the arch at Carey's Mine in the bed of the little brook which flows there, and we detect it again in Collins's Mine, about a mile further W. At both places the dips are of moderate steepness, the S. dip at Collins's being 20°, and the N. 30°. In Carey's Mine this axis lifts to the day a seam of coal 4 feet thick; and in Collins's Drift, the coal-bed which arches has a thickness of 8 feet, and is a higher coal. Comparing its position with those of the coals visible in the cut of Warrior Creek further W., this bed appears to be the fifth in the series of the large or workable seams above the conglomerate.

Anticlinal C, *Basin* 19.—The next anticlinal flexure within the basin which calls for notice is one which has thus far been detected only where it has been intersected by Warrior Creek on the Babb Lot, where it is well displayed on the Railroad and mining section there developed. It interrupts the general N. dip of the strata towards the centre of the basin, and turns at least five of the middle coal-seams over into a steep S. dip of 60° or 65°; the N. side of the flexure dipping 40° or 45° N.

The coal-seams which it thus causes to arch are apparently the lowest of the middle group,

or those next above the horizon of the Baltimore Bed; not assuming it as certain, however, that this maintains its integrity so far to the W.

Anticlinal D, *Basin* 19, *or that of Bergman's Run.*—We come now to a sharp flexure in the strata, close to the foot of the mountain, intersected by Bergman's Run, about half a mile S. of the Tavern on the main road of the valley. This axis may possibly possess considerable length; but being close under the foot of the mountain, the strata are too much concealed for us to trace it. It is remarkable for the excessive steepness of the S. side of the flexure, the dip towards the mountain being nearly perpendicular. This posture of the strata, giving rise to a precipitous wall, causes the stream here to take a sudden leap, and form a really beautiful cascade. The N. dips from the axis are extremely gentle, even at some distance from the axis-line not exceeding 15°.

The coal-beds lifted to the day by this broken flexure are evidently very low in the Coal-measures. (See the Section at Bergman's Run or Gulick's Tavern, fig. 291.)

Anticlinal E, *Basin* 19.—N. of the last-described anticlinal commences a longer and much more conspicuous one, ranging nearly centrally in the basin. Its first traces are seen in Bergman's Run, about a thousand feet S. of the Tavern on the road, its effect being a saddle in one of the coal-beds of the stream. Here, however, the flexure is extremely gentle, neither dip exceeding 5°. Some three-fourths of a mile further W. we may discern it more distinctly, just N. of the South-dipping outcrop of a bed of coal mined to a small extent a few hundred feet S. of the road; the sandstones between this coal and the road dipping N. from the axis. A little further W. the same anticlinal, or what appears to be the same, is visible in the small mine upon the thick seam of coal called Wright's Bed, where the coal is entered S., and dips W., actually saddling over the axis.

This anticlinal, or one very nearly in its range, now crosses the road, and pursues the bed of the narrow valley traversed by the W. Branch of Lee's Creek. Here the anticlinal structure of the valley is well exhibited for a mile or more in its escarped and precipitous sides, and the opposite direction of dip of the two sets of exposed strata. How far this anticlinal is prolonged towards the W. it is hard at present to say; but it seems not to reach the obscure cross-road which extends through the forest from the inn called "Traveller's Rest" to the North Road near Sorber's.

An outcrop of coal is visible in the bed of the Anticlinal Valley, a few hundred feet N. of the main road, and another coal, known as Kocher's Opening, occurs close to the axis just S. of the same road; but nothing can be established at present regarding the places which these coals occupy, nor anything positively indeed respecting the position to be assigned to the large bed called Wright's, which may or may not be identical with the others.

Anticlinal F, *Basin* 19.—Another anticlinal, accompanied by apparently gentler dips than those which attend the preceding, appears near the main road further Westward, a few hundred feet N. of the conspicuous outcrop of coal visible on the roadside, and called Lesher's. The Westward extension of this axis has not been ascertained, but it seems not to cross the road running N. from "Traveller's Rest."

Anticlinals G *and* H, *Basin* 19.—Two other anticlinals have been detected by us within this general synclinal belt in the W. end of the coal-field; the more Southern of these occurring in the hill between the two Southern spurs of the Hog Back, and the more Northern ranging just N.

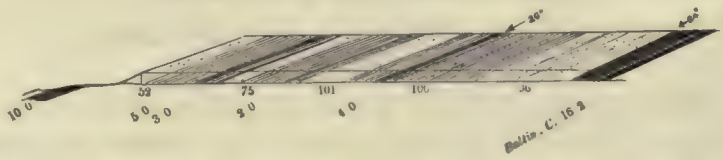
of its third and longest spur, and prolonging itself in the direction of Shickshinny. Too little is known at present of these anticlinals, or of the coal-beds disturbed by them, to enable us to trace them with more detail, or to exhibit their influence upon the strata. The approximately correct section of the district of the Hog-back is presented in the column, (see Fig. 294.)

Other flexures besides those we have now enumerated, will probably be brought to light by future mining operations within this synclinal belt, and those which have been here described will unquestionably become better known and more distinctly developed; but quite enough has been detailed concerning these and all the other discoverable undulations of the district to furnish a clue to the distribution of the many beds of valuable coal which it embraces, and to prove a useful guide to all future explorations and mining undertakings.

Distribution of the Coal in the E. End of Basin 19.—Reverting to the E. end of the general basin before us, with the view of recognising the basining-out of its Coal-measures, we may observe, by consulting the Map and the Geological section which follows the Easton Turnpike, that while the lower large coal-bed, or Jamieson's, crosses the road to basin out at some distance E. of it, between the foot of the mountain and the Anticlinal Axis No. XIX. E., the upper larger coal, or Great Baltimore Bed, is not cut by our section, but basins out or is washed away to the W. of it. This valuable layer of coal is, in fact, disposed in two basins within this belt—the larger one lying at the foot of the mountain, and heading several hundred yards W. of the Turnpike, and the lesser, a much shorter and narrower one, running only a few hundred feet E. from the Wilkesbarre Company's Main Slope. The anticlinal which divides these two Southern basins of that Company's lands ranges just S. of their slope, lifting there the rocks which immediately underlie the large Baltimore Bed; but declining to the Westward, it soon permits the coal-seam to saddle its axis; and there is reason to believe that the undulation altogether subsides within a range of perhaps half a mile towards the W. Considering it, therefore, as only a roll in the strata, I have not enumerated it among the leading anticlinals, nor given it a special designation. Its influence, however, is all-important upon the mining operations conducted within the coal estate of the Wilkesbarre Mining Company.

Lane's Tunnel, entering the S. side of this basin, penetrates to the Great Baltimore Bed, and cuts the two overlying coals, as shown in the annexed engraving.

Fig. 286.—Lane's Tunnel, E. of Solomon's Gap.



Blackman's Slope, or Slope No. 3, at the Wilkesbarre Company's Mines, is 70 yards down, and goes deep into the basin. It ends at a dip of about 30°, and the top of the slope is about 60 feet above the adit at water-level, which is now being constructed to dispense with the upper part of the slope lifts, and the return inclined plane.

This water-level adit is to be driven 45 yards through rock into the coal-bed.

Beneath the big coal in Blackman's Mine, the coals are—1st, A bed which crops out at the Toll-gate. It is a 7-feet coal, pretty good, and in tiers of 18 inches and 1 foot of coal; it is about 200 feet below the Big Bed. 2d, A coal which is 6 feet thick, and is separated by 5 feet of hard fire-clay,—Stigmaria Shale.

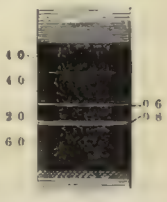


Fig. 287.—Baltimore Bed (Blackman's), E. of Breaker.

At an interval of 60 yards in the tunnel are the 3d, 4th, and 5th Coals, separated by 3 feet

of slate; while the lowest of them is separated by 2 feet of slate from the big seam of coal called the Nineteen-feet Coal, but actually 14 feet thick. These three closely-adjacent beds are each 3 feet thick, and one of them yields a Brown Ash.

The Big Seam is the lowest, at present, known in this vicinity.

The bottom layer of the Lower Big Coal of the S. side of the basin at the Wilkesbarre Company's lands at Solomon's Gap is Red Ash Coal.

The coal of the Mill is regarded as the bottom tier of the Nineteen or Fourteen-feet Coal. At the Wilkesbarre Company's land the lower division of the Lower Big Coal lies just on the conglomeritic rock, with only a few inches of shale intervening.

SECTION OF THE BIG COAL.

	Feet.	Inches.		Feet.	Inches.
Coal, ...	1	3	Bony Coal, . . .	0	8
Shale fire-clay, . .	0	0	Coal, ...	2	8
Slaty Coal, . . .	2	0	Slate, ...	0	0
Good Coal from . .	8 to 9	0	Best of Coal, . . .	4	6

The Eight-feet Rough Coal of the Baltimore Mines is much further from the main bed at the Wilkesbarre Company's Mines, being at its last S. outcrop at the foot of the mountain as much as 200 feet S. of the outcrop of the Big Coal.

At Jamieson's old opening on a 19-feet bed of coal, the signs of metamorphism are quite abundant. The coal exhibits in the direction of the strike long chunks like planks; the Bird's Eye surfaces are in this direction, an exception to the general rule. The dip is from 20° to 25° N. 30° W.

COALS IN SOLOMON'S GAP (SEE SECTION, PLATE V.)

The lowest coals of the Wyoming Coal-basin are finely exhibited at Ross's old mines in Solomon's Gap, immediately below Solomon's Falls. Here the lowest bed is worked by a drift at the Creek level. The same coal is to be seen in its entire thickness in the Railroad cut at the Red Mill. It is about 8 feet thick, with several slate-partings. Its character appears to be rough, and in some benches quite bony. The slate overlying it is about 3 feet in thickness. Its dip is about 30° to the N.N.W.

The next vein ascending is also opened by a drift at the water-level; it is about 8 feet thick, and has about 2 feet of parting-slate in its centre. The character of this seam, as well as of all the coals at this locality, is quite rough and bony. About 9 feet of slate intervene between this and the next overlying vein, which contains 3 feet of impure coal; it has not been opened at this place.

A flaggy sandstone, 10 feet thick, forms the roof of this bed, and the bottom of an 8-feet thick coal next above it is here opened by a water-level drift. It appears to lie in three or four benches; the upper of which is 2 feet thick, and is separated from the others by 3 feet of slate. The several seams here opened appear to be divisions of one and the same large bed.

At this point there would seem to be some confusion in the stratification; but by tracing the course of the fire-clay, which overlies the last-mentioned coal, it proves to be a simple though somewhat abrupt turn of the vein in the form of an anticlinal, by which it is thrown below the water-level.

The last and highest coal here opened is a 10-feet coal, with 1 foot of bottom slate. It is entered by a number of drifts at the water-level, inasmuch as its dip is but a *very* gentle one to the N. It lies in four benches of about equal thickness; the partings being quite thin. Its character, like that of the rest, seems to be rough. Without doubt, it is the so-called 19-feet vein of this region, either entire or in union with the bed below, from which it is separated by fire-clay.

I am induced to regard this as the 19-feet coal-seam, from the following considerations :—

1. It seems to lie in a position with regard to the lower conglomerate which that bed generally occupies; that is to say, we here see at least *two*, and probably *three* seams underlying it.

2. There is a considerable thickness of slate overlying it; probably as much as 50 feet. Now, by measurement in Grey and Landmesser's Tunnel, at the back end of which the 19-feet vein is known to exist, there is about the same amount of overlying slate, and I know of no vein so low in the series which has so great a thickness of roof slate.

3. Another reason is to be found in the flexures of the strata at this locality. On the inclined plane, a few hundred feet to the N. of these openings, there is a small cut at the little breaker of these mines, which exhibits a small anticlinal axis, by which the 19-feet bed would appear to be thrown some few feet above the level of the plane, and made to turn over into N. dips; and this N. dip of the vein may be traced immediately to the outcrop at the back end of Grey's Tunnel. The truth of this supposition will depend upon whether the vein here, poorly exposed in the road cut, is really the Big Ross vein; and if so, whether it is actually traceable to the outcrop S. of the tunnel. A leader or thin coal on the Railroad seems to be several feet thick in the tunnel; that they are one and the same there can be little doubt, as at both localities the same coarse flaggy sandstone, containing numerous pebbles, overlies the bed. This is an additional argument for considering the anticlinal seam as the 19-feet vein, whether it be the same as the Big Ross vein or not.

The 19-feet coal has been mined; 1, At Ross's mines, in Solomon's Gap, by water-level drifts; 2, At the back end of Grey and Landmesser's Tunnel, which was driven in 241 feet to reach it, (it dips N. at this point about 25°); 3, By an open cut on its outcrop about a quarter of a mile E. of Grey and Landmesser's shaft; 4, It has been driven to, in Jamieson's Tunnel, about half a mile E. of the shaft; 5, Also in the vicinity of the Wilkesbarre Company's new mines by a tunnel now abandoned, the so-called Blackman Tunnel; 6, By open cut and drift at Parrish's old mines, about half a mile N.E. of the Prospect Rock House.

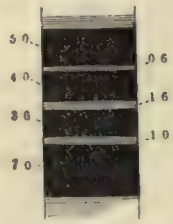


FIG. 288.—Lower Big Coal at Landmesser's, E. of Solomon's Gap.

At none of these localities is it now worked; nor is it, to my knowledge, mined anywhere on the S. side of the river. The relations of the so-called 19-feet bed, and the Baltimore seam near Solomon's Gap, are illustrated in the cut here presented of Grey and Landmesser's Tunnel. (See Fig. 289.)

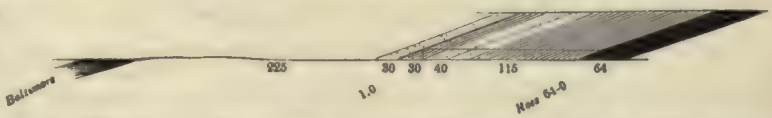


FIG. 289.—Grey and Landmesser's Tunnel, near Solomon's Gap.—1 *inch* = 200 *feet*.

DISTRICT W. OF SOLOMON'S GAP.

West of Solomon's Creek perhaps a mile, occurs a gully, upon which several coal-seams have been opened on Wright and Conyngham's land. I know no name for the ravine. The tenant was William Stapleton. Carey's Coal-bed is opened some distance up the stream.

The following section made on Carey's Run, or Sugar Creek, exposes the seams underlying

the large or Baltimore Bed, and enables us to arrive at some satisfactory conclusion as to the number and thickness of the veins constituting the Coal-measures of the Wyoming Basin.

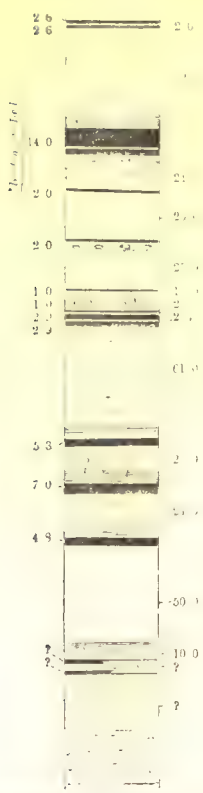


Fig. 200.—Carey's Run, 1½ mile W. of Solomon's Gap.

The first or uppermost coal seen is about 7 feet thick, consisting of two benches 2½ feet each, separated by an intervening slate 2 feet in thickness. The dip is 30° N. The W. bed is 14 feet thick, but not very well exposed, dipping 45° N. This is supposed to be identical with the Baltimore bed. The third vein is scarcely 2 feet thick; and then follows the fourth, which is about the same size; under it is a band of ore containing sulphuret of iron. The fifth bed is well exposed, forming a roll with steep dips of 50°, soon, however, rising again with a N. dip of 30°. It is about 10 feet thick, and may be thus described:—Coal, 1 foot; slate, 2 feet. Coal, 2 feet 9 inches; slate, 2 feet 3 inches. Coal, 12 feet 9 inches; bottom slate, 4 feet, full of Stigmaria; coarse sandstone, massive. This roll also repeats the overlying vein. The sixth bed dips 27° N., and is over 5 feet thick. Coal, good, 4½ feet; slate, 6 inches. Coal, 8 inches; slate, full of Stigmaria, and in its lower part large lenticular masses of iron-ore. The seventh bed dips 30° N., and is more than 7 feet thick. Coal, 5 feet; slate, 1 inch. Coal, good, 2 feet; slate (Stigmaria), 3 feet. Coal, 8 inches.

Slate intervenes between this and the next vein, the eighth, which dips 40° N.; and, as far as could be ascertained, is 5 feet thick.

The next seam, the ninth, is evidently two layers of coal, separated by a slate 4 or 5 feet thick; the dip is steep. The massive sandstone under it forms a bold ledge, over which the water falls. Steep dips continue for perhaps 70 or 100 feet, when it changes to a S. dip of 25°.

This again changes to a N. dip of 25°, the sandstone forming a rapid of 100 feet in length. The next dip is 25° S., succeeded by a dip of 30° N., forming several rapids. The conglomerate then appears dipping 40° N.

This section exhibits the rolling character of the strata, though it would be difficult to trace any one of these rolls far in either direction.

It would appear from these exposures that no less than seven seams of coal lie between the Baltimore bed and the Conglomerate, four or five of which are of sufficient thickness to be wrought. The section may serve as a guide in searching for beds along the mountain, between the outcrop of the Baltimore vein and the Conglomerate.

In that part of the valley between Solomon's Creek and the Wyoming Coal Company's railroad several mines exist. There is a coal at Inman's on the Berwick Turnpike; it is 3 feet thick, dipping 25° N.W.

Caleb Inman's bed, also 3 feet thick, is opened on the new road on a hill, near a stone bridge over Solomon's Creek. It dips 20° S.S.E., and is evidently the same bed as the preceding—a synclinal trough existing between the two openings.

On a little branch of Sugar Creek, about 800 or 1000 feet from the back road down the S. side of the valley, a coal is opened in a tunnel driven by Mr Holland of Wilkesbarre; no other coals were cut. The dip at the surface is displayed in massive sandstone N. 55-60°. A distance

of 100 yards from the tunnel on Preston's land coal has been taken from the surface. The bed measures 6 feet in two benches separated by thin slate—dip. 30-35° N.

Two coals have been proved by tunnels on Preston's land. The tunnels are 115 yards asunder, and on different levels ; the same beds are cut in both. The two beds are 6 feet thick each, and are distant 120 feet in the upper tunnel. A third coal, 4 feet thick, is found over the upper coal of the upper tunnel. It lies 100 feet from the mouth ; its dip is quite flat, or even Southward ; but it rolls over, and is cut in the lower tunnel where it is faulty.

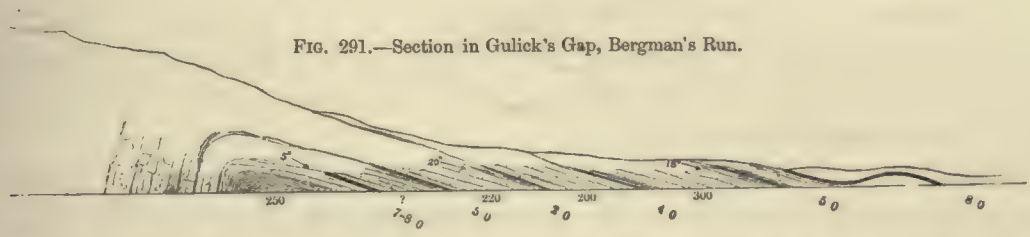
The upper 6-feet coal, and that opened near Holland's old tunnel above, are thought to be the same seam.

Continuing W. in the coal-basin there is a satisfactory exposure of the strata on the railroad of the Wyoming Coal Company about six miles from Wilkesbarre : it exhibits a series of coals overlying the great lower seam.—(See section from the Susquehanna to Warrior Path Gap, Plate VI.)

The uppermost bed of the series on the railroad of the Wyoming Coal Company was cut in a tunnel driven to it by Mr Holland ; it is 6-8 feet thick, and dips about 20 N°. ; the same bed is opened 100 yards farther W., and still farther a slope was sunk 100 feet upon it.

Following the railroad up the creek, we have in the creek and the cuttings on the Babb lands fine exposures of coal, six or seven in number. They are shown in our section. The average thickness of these coals does not exceed 4 feet. Several of the beds are repeated by a sharp anticlinal, which from a dip of 40° or 45° N. turns them over to S. dips of 60°. Near this the railroad branches, one fork going to an old tunnel driven by Mr Holland to meet a large coal, the other to the Warrior Path Gap of the Little Mountain. Our section follows this, and exhibits several fine beds of coal in the notch. The first of these is a compound bed opened by a drift on Mr Rummage's land. The upper portion is 6 feet thick, the lower 9, separated from the former by 18 inches of slate. The dip is 30° N. S. of this 100 feet horizontally a second bed has been opened ; it is 9 feet thick. A few hundred feet further S. a third bed, capped by pea-conglomerate, and resting on thin-bedded sandstone, has been proved. It is said to measure 12 feet. This is within 100 yards of Collins's Sawmill, behind which the Seral conglomerate rises from the water-level at an angle of 40°. In the conglomerate a thin coal of 3 inches has been found.

Fig. 291.—Section in Gulick's Gap, Bergman's Run.



Our section of the Gap in the Little Mountain at the back of *Gulick's Tavern* (see Fig. 291), about nine miles from Wilkesbarre, displays several coals. The uppermost of these is gently arched above water-level : it is proved to be fully 8 feet thick. Below this is a bed of bone coal and slate, containing impressions of Lepidodendron, 5 feet thick. The third coal is 4 feet thick, and has been mined to a limited extent. It dips N. 7° to 10°. The next bed is thin, not exceeding 18 inches. It is overlaid by slate containing iron ore. Below this is a workable coal 7 or 8 feet thick. Its quality is fair, and it has been mined. Something over 100 yards S. of this, at

the falls of the creek, on a nearly perpendicular Southern dip, a coal was seen which, including bony coal and slate, measured 11 feet. It is all more or less squeezed and faulty. The lower 6-feet are the best. This coal is not represented in the section.

Wright's coal, three-fourths of a mile W. of Gulick's, is a large bed, having 10 feet of coal in all, thus :—

Slate and Coal, 3 feet ; Bony Coal, 2 feet ; Good Coal, 8 feet.

It dips W., turning round with the dying-out of the anti-axis from the E. Its cover is slate, &c. It is in the same hill with South-dipping coal, 300 yards E. of it. This S. dip of coal is not all seen ; it looks like the West-dipping bed, and dips S. 15°. On the N. slope of the same ridge the dip is 30° N.

I am in doubt whether the denuded axis W. of Wright's coal, W. of Gulick's, is not a little N. of the axis of the coal itself.

At Fitzgerald's on the Schoolhouse No. 3, there is a coal-bed 7 feet thick, dipping N. 30°. Under this there is said to be one 14 feet thick. On John Schleppy's Farm, in the same valley of the N. Branch of the Nanticoke Coal, a little W. of the Schoolhouse, a coal-bed lies in the hill, and dips S. 30°. It is 7 feet or more thick ; a boring of 8 feet did not go entirely through it.

At Schleppy's, one-fourth of a mile W. of the cross connecting-road, and adjoining Meyer's, there are 3 coals opened. One at the road, with N. dip, is 7 feet thick ; one in the ravine about 5 feet, with steep N. dip ; a third on the N. side of the basin 7 feet, and dips S.

John Hoover, near the Newport Road, has a Red Ash coal, 6 feet thick, with slate-partings in it. It dips gently S., being near the centre of the basin rising Eastward, and the road being near the E. end of this coal.

B. Vandermark's coal, near Hallenback's Mill, dips into a trough ; it has 5 feet of coal with slate 10 inches thick in the middle—in all, 6 feet in thickness.

A little further W. is coal about 3 feet thick on Staymetz's Farm, now shut up ; dips gently South.

Just N. of Hollenback's Mill on the road crossing over from Nanticoke Creek to the N. road, there is a double axis, very sharp, like that of Newport Centre : it is, I think, the same prolonged. It runs into the middle spur of the Mountain.

The synclinal of Vandermark's Hill runs from between the two ribs of the conglomeritic sandstone at the road, through the N. side of the valley of Nanticoke Creek. The anticlinal S. of it runs along the S. edge of the same valley.

We traced the synclinal and anticlinal axis of Vandermark's Hill eastward, and found that they died out by the time they approached the road from the Methodist Meeting-house to Newport Centre ; they expire a little N. of the S. fork of the road.

The synclinal knob of sandstone a few hundred yards S.W. of Newport Centre on the same road is a more Northern synclinal, and the axis N. of it, or that first S. of Newport Centre, expires at the same road, and a little W. of it, and is the feeble axis of the road from Dodson's Schoolhouse northward. It does not go much W. of Newport Centre. All these gentle flexures of the road S.W. of Newton Centre imply a rapid declension of Vandermark's sharp saddle and basin.

Iron Ores, Lee's Mines, Nanticoke.—Iron ore is said to exist beneath the 8-feet coal in three courses, within 20 feet of slate—

1st, Below the coal 20-inch balls of lean ore.
2d, 14 inches of stratified ore, quality not known.
3d, 6 inches of cubical stratified ore, rather lean.

The opening is now closed.

From Nanticoke Westward.—That portion of the coal-field which is W. of the parallel of Nanticoke presents much complexity of structure.

The Susquehanna River forsakes the coal-basin at Nanticoke to follow the deep trench in the Umbral red shale between the mountains of Vespertine sandstone and Seral conglomerate. Suddenly turning again to the left it crosses the W. end of the coal-field at Beech's Mines, leaving a small portion of the trough on its right bank, and escapes through the Southern Mountain into the Berwick Valley.

The Nanticoke Mountain presents to the river a bold and nearly perpendicular escarpment of outcropping Umbral red shale and sandstone. Its S. slope into the basin for some miles W. of Nanticoke is long and gentle, the result partly of a general gentle dip, and partly of numerous undulations. This structure prevails as far Westward as a notch in the summit of the mountain called Dean's Gap, W. of which the crest becomes a lofty ridge, nearly to the river, where it declines, and is composed of the conglomerate alone.

The Little Mountain, the S. boundary of the coal-field, is broken in its outline opposite to the Nanticoke Gap, by a series of gaps, and terminates at the Susquehanna in a bold knob.

The central part of the valley also becomes elevated and broken into ridges, the highest of which is known as the Hog-back. Numerous streams descending from the mountains enter the Coal-measures : one of these, Black Creek, rises in the valley between the Little and the Wyoming mountains, breaking through the former mountain nearly opposite to Schleppy's, and flowing Westward ; it precipitates itself over a high and bold ledge of the Seral conglomerate, forming one of the most picturesque scenes in this valley, celebrated for its beauty.

One branch of the Nanticoke Creek, usually called the Forge Creek, rises a short distance W. of Dutter's, flows Eastward along the N. portion of the valley, and, uniting with another branch of the same stream coming from the S., empties into the Susquehanna not far from Lee's Coal-bed.

From Lee's Mine southward to the village of Nanticoke, several coal-beds have been opened, the dimensions and distances between which are given in the following description, which we have illustrated by a cut.

FIG. 292.—Section from Lee's, southward, at Nanticoke.—1 *inch* = 600 *feet.*

The uppermost coal-bed is called 5-feet thick, but it yields not more than 3 feet 6 inches of good coal ; it dips 15° S.

An interval of 1000 feet horizontal (at 15° dip) succeeds coal, supposed to be a thin bed, exposed in a small run S. of Alexander's Old Store. Interval of 150 feet to a coal cropping out on the same run, passing a few yards S. of the Blacksmith's Shop : its thickness is unknown.

Interval, 50 feet. Coal, Thompson's bed, dip 25°, opened again near Forge Creek, where the dip is 12° S. 10° E.; thickness, 5 feet at the village. It contains coal 1 foot, slate 4 inches; coal 3 inches, slate 1 foot; coal 3 to 3½ feet, bottom slate containing carbonate of iron. At Forge Creek a tunnel is driven to it, where it reads thus: Coal, slaty, 1 foot; coal, 3½ feet, separated by 1 inch of slate; interval, 100 (?) feet; coal, bony vein, impure, slaty, 2 (?) feet, thin; interval; Mill's Vein, impure, slaty, 2 feet thin; interval, 100 feet. Coal, Mill's Vein, 7 to 8 feet; a good coal, burns freely, yields a white ash, has a conchoidal fracture. It runs S. of the Wilkesbarre and Nanticoke road. Interval, including a bed of carbonate of iron midway, 80 feet. Coal, Blacksmith Vein, said to be from 3 to 4 feet thick; crops out 115 feet N. of Mill's Vein, or just N. of the road. Interval, 80 feet; lower portion sandstone, quarried, dip 20° S. 10° E. Coal, Tunnel Vein, bent by an anticlinal, and dips 10° in opposite directions. The flexure is not traceable to the Eastern or Western bed, overlaid by slate. Interval, 35 feet. Coal, Forge Vein, 6 feet opened on the Creek; dip 15° S. 10° E. How far the lower great bed (Lee's) may lie below the Forge Bed is not certainly known. If the horizontal distance between their outcrops be called 300 yards, and the dip of Lee's Vein, 12°, be made an average (the rocks of the interval supposed, of course, to dip regularly), the one will underlie the other by 188 feet; if an average dip of 10° be preferred, 156 feet. Unknown flexures, however, may exist, and then they will approximate still more closely. By this supposition the Mill Bed falls naturally into the position occupied by the Baltimore Vein in the series of beds; that is, from 350 to 400 feet above the Seral conglomerate.

Along the Northern side of the valley few openings had been made up to the year 1840, at the date of our first explorations; nor have any important mines been established since. About 1½ miles from Lee's Mine, at the base of Nanticoke Mountain, Mr Holland had partially opened a large vein, 12 or 14 feet thick, which seemed identical with Lee's. Michael Gower had opened a vein, 7 feet in thickness, in the side of the River Mountain. Philip Haupt's Bed is also a 7-feet vein, and is probably the same as Gower's.

Michael Steinmetz had entered a coal-bed in the valley not far from the base of the River Mountain, and a short distance E. of the general section made at Schleppy's. It is 5½ feet thick. John Vendewert had also opened a vein of nearly the same thickness, and only a short distance from the former. The two openings are probably on the same vein.

A general section made across the valley at Schleppy's, 5 miles W. of Nanticoke, embraces several good beds of coal.

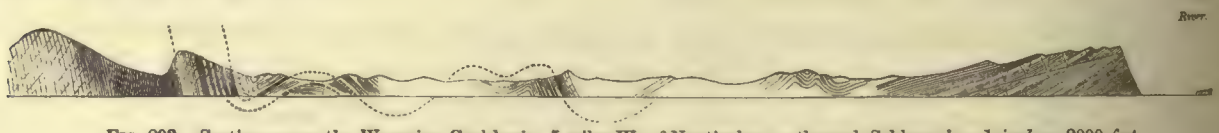


Fig. 293.—Section across the Wyoming Coal-basin, 5 miles W. of Nanticoke, or through Schleppy's.—1 *inch* = 2000 *feet*.

The summit of the Nanticoke Mountain is occupied by the alternations of the Seral conglomerate and the high beds of Umbral sandstone and shale: only its Southern brow exhibits the coarse main mass of conglomerate. Upon the slope the Coal-measures appear with gentle dips: Miller's Bed dips 20° S., opened at a considerable distance from the summit, and is said to be 7 feet thick; its position in the series could not be ascertained. From Miller's coal to the beds of the Hog-back the exposures are few; but the dips observed show that there are several flexures.

The Hog-back.—Forge Creek breaks through the ridge, and finely exposes the strata in the gap. The following vertical section exhibits the number and thickness of the beds: The upper coal, called the Thornton Vein, dips 35° N., and is said to be 9 feet thick. The next vein to the S., 80 or 90 feet below the Thornton, is a coal which has not been sufficiently developed; only 5 feet of it were seen. The next vein, called the Perpendicular Vein, measures from 12 to 16 feet in thickness; it is exposed on both sides of the creek. On the W. side this coal measures 16 feet, and is apparently less crushed than on the E. side. Under this bed occurs a hard coarse carbonaceous sandstone, 45 feet thick; then a coal-bed, from 6 to 12 inches; then slate, 9 feet; under this a band of impure iron-ore, nearly 2 feet thick; then dark coarse carbonaceous sandstone, 22 feet. Below this the strata to the next coal-bed are not well seen. The next coal-bed was insufficiently opened, but exhibited 5 feet of coal.

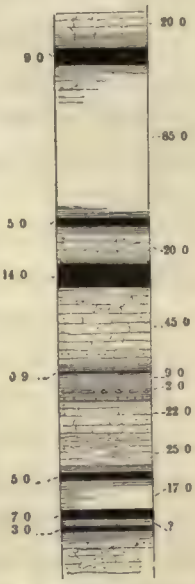


FIG. 294.—Hog-Back, 5 miles W. of Nanticoke.

Server's Vein lies 17 feet below the last, and is from 6 to 8 feet thick. Its coal is somewhat crushed, being near the flexure. A short distance below it lies another bed, said to be 3 feet thick. The entire thickness of coal-measures embraced in this section is about 36 feet. The Perpendicular Vein, so called, may possibly be the same bed as Server's and Holland's.

Proceeding Southward with the section, Server's coal-bed by a roll turns to a S. dip of 20°, rising, however, again at a short distance with a gentle N. dip. Beyond this a great extent of surface Southward exhibits no exposures, but doubtless contains a synclinal trough simple or complex, in the N. portion of which the Hog-back beds may descend and rise again, dipping Northward. Here is seen a bold bluff formed by the outcrop of a coarse pebbly sandstone. Beneath it appears a coal-bed, which may be the great bed. Some distance farther S., and almost on the axis of the anticlinal that separates this synclinal from the next, or that which runs along the foot of the Little Mountain there, is seen another coal-bed, and farther on, and among S. dips, a thin bed of iron ore. A bold ledge then succeeds facing the N., and corresponding to that last described, containing the outcrop of a coarse pebbly sandstone, with that of the great coal-bed at its foot. Still farther up, this rock forms a high hill capped with sandstone, behind the summit of which is an upper bed of coal, at the old turnpike road, lying cramped in the very axis of the synclinal trough. From this point Southward up the long slope of the Little Mountain, the rocks crop out with a very steep N. dip. First is seen the final outcrop of the great bed 12 or 14 feet thick, with a slate near the middle, and beneath it a massive sandstone. No more coal-beds are visible between this line and the conglomeritic strata which form the upper slope and summit of the mountain, on the S. side of which vertical precipices overhang the narrow valley of Umbral red shale.

From this general section, it is apparent that the strata of the basin are much disturbed or undulated. The coal-opening made by Holland for the Wyoming Coal Company, near the base of the mountain, and the outcrop of the great bed (Knoop and Stiver's), dip S. into the mountain.

In consequence of the upturning in the strata, this great bed has been spread over a considerable surface. Koker's bed is opened a short distance E. of our principal section on the S. dip of its synclinal roll; the bed itself exhibits some disturbance.

Krupp's coal-drift is perhaps half a mile E. of Koker's, and in the same position, near the foot

of the Little Mountain. Its dip is to the S.W., about 14° on the N. side of the synclinal trough.

The Wyoming Coal Company opened this large bed in two places along the base of the Little Mountain. One of these is not far to the Eastward of Cooper's, though it lies a little further to the S., or nearer the mountain. Where the drift enters the bed it is horizontal, and continues so for 200 feet, when it rises with a N. dip, which increases to 55° towards its outcrop on the flank of the ridge.

The thickness of this coal-bed, roughly measured, is 18 or 19 feet: its character, as well as it could be ascertained, is as follows:—

Coal, 8 or 9 feet, good quality, slate 2 feet; *coal*, 2 feet 9 inches, good; *coal* 9 inches, slaty; *coal*, 1 foot 10 inches, good; *slate and dirty coal*, 1 foot 10 inches; *coal*, 2 feet 9 inches, under slate; coal and Stigmaria. Near the entrance to the drift the upper portion of the vein was distinctly seen, where it presents 8 or 9 feet of excellent coal. Farther to the Eastward, in a corresponding position, Holland's second opening occurs. It has been entered by a tunnel. Rocks are observed in a ledge 100 feet or so in front or N. of the tunnel, dipping 35° N. In the tunnel the dark-grey coarse sandstone at its entrance rises at first into N. dips, but gradually falls, and rolls over to the S. The coal-bed, where entered by the tunnel, dips gently to the S. If the tunnel were driven farther in, the vein would doubtless be again intersected where it rises with a N. dip to its outcrop on the mountain's side.

About 200 yards E. of the latter opening, in a ravine, several coal-beds were observed evidently underlying the large bed.

The first bed in the section on a line with the tunneled bed just described was nearly horizontal, inclining perhaps a little to the S., then gradually rising till it outcrops on the bench that skirts the mountain. The strata continue rising with a N. dip of 50°, constituting a fine exposure of rather flaggy sandstone, underneath which is a coal-bed, of a thickness unknown. Under the coal vein occur 6 feet of compact slate, succeeded by a heavy mass of sandstone, from 35 to 40 feet in thickness, with an average dip of 20°. It is a coarse grey rock, full of small pebbles. A few feet of slate succeeds, then a band of iron ore 10 inches in thickness, apparently of good quality. A thin seam of coal underlies the ore; slate next appears, embracing several thin bands of ore, followed by a coal-bed 7½ feet thick, and reading thus: Coal, impure, from 6 to 12 inches; slate, 14 feet; coal, 2 feet; slate, 6 or 7 inches; coal, 4 feet, generally good, but slaty in the middle. The bed dips about 30°. N. It is underlaid by sandstone, then a little slate, when suddenly at a waterfall the strata dip steeply S., nearly vertically. Underlying the main mass of sandstone which forms the falls, there occurs a vein of coal, rather crushed, about 7½ feet thick. Evidence of another seam, perhaps thin, is observed 20 feet N. of it. From this point up the ravine nothing farther could be seen, and the rest of the section is completed from the few exposures in the side of the mountain.

Tracing the large vein Eastward, it appears again at Stiver's Bed, at the base of the Little Mountain, nearly opposite Nanticoke. Its dip is S. about 15° into the mountain, corresponding in position to the opening above described. Further up the mountain it crops out, with a dip of 30° N., from which, to the summit of the mountain, the dips gradually increase, becoming 70° in the Seral conglomerate. At the old opening, a fourth of a mile S. of Mr Lyon's house, it reads thus (top slate, from 20 to 25 feet):—

Coal, crushed, 4 *inches;* checkered, 11 *inches;* slate, one-eighth of an inch.
Coal, 11 *inches;* slate, one-eighth of an inch; *coal*, 11 inches; slate, one-eighth of an inch.
Coal dirt, with thin seams, 18 *inches;* slate, 1 inch.
Coal, 8 *inches;* slate, 3½ inches.
Coal, 22 *inches*, dirty; *pure*, 12 *inches;* slate, 4 inches.
Coal, 33 *inches;* slate, 1 inch.
Coal, 10 *inches;* slate, 3 inches.
Coal, 32 *inches;* slate, 2 to 3 inches.
Coal, 26 *inches;* bottom slate?—18 feet.

West of the section made at Schleppy's, the only veins mined to any extent were those opened by Mr Henry Colt of Wilkesbarre, for the Philadelphia Company, about 3 miles from Schleppy's, or one mile W. of Mr Dulter's. The valley gradually contracts in breadth, and the Coal-measures lessen in thickness, and the conglomerate occasionally makes its appearance in the floor of the valley. One of Mr Colt's openings is at the foot of the Nanticoke or River Mountain, and has a thickness of nearly 16 feet; it is undoubtedly identical with Lee's. The following is the character of the vein, so far as it has been developed (the drift has only been driven in for a short distance):—*Coal*, not mined, 5 *feet; Coal*, 4 feet 6 inches; slate, 6 inches; *Coal*, 4 feet 6 inches.

Fig. 295.—Colt's Coal.

Over the vein occurs a greyish micaceous sandstone for 2 feet, surmounted by a great mass of a very coarse grey sandstone.

A large bed of coal, 13 feet thick, was opened by Mr Colt at the S. base of the ridge called the Hog-back. Black Creek flows between this ridge and the Little Mountain. The coal-seam lies under a heavy mass of coarse sandstone, similar in appearance to the rock overlying the large 16-feet bed, with which there is every reason to believe it identical.

Above the 13-feet vein in the Hog-back (distance not known) occurs another, about 6 feet thick.

The following section, made half a mile W. of the preceding opening, on a line running S. from Black Creek, will show the contorted character of the strata of the Little Mountain.

Fig. 296.—Contortions in Little Mountain, E. of Susquehanna River.

West of the mines of the Philadelphia Company, as far as the river, few beds have been opened. The large vein has probably been struck in one locality, 200 yards from the river: here it is about 8 feet thick.

In the valley at Black Creek Falls the conglomerate appears, and the section (fig. 296) showing the structure will at the same time exhibit the shallowness of the Coal-measures.

About a mile eastward of the section at Schleppy's house, Mr Kreemer has exposed a vein of coal 3 feet thick, and higher up the same stream has made a boring into a large vein of coal, from 8 to 9 feet in thickness. From this point a section to the summit of the River Mountain strikes the top of the mountain at a large exposure of massive strata, known as the Big Rocks, E. of the notch called Dean's Gap.

Houpt's bed, to the W. of the last section, dips 15° or 20° S., and corresponds in position to the bed reached in Kreemer's boring. A gentle undulation occurs to the N. of it, which passes also N. of Beattie's, at the gap. The bed may be traced W., and will probably be found under

a ledge of rock S. of Mr Beattie's, where the Seral conglomerate is near enough to prove that the bed is low in the series of the Coal-measures.

Coal-Basin W. of the Susquehanna.—A few miles W. of the Susquehanna the termination of the Little Mountain, or, as it is here called, the *Stony Ridge*, unites with the Nanticoke Mountain in a bold knob. The Coal-measures remaining on the Seral conglomerate are thin, and cannot embrace more than two, or at the utmost three, distinct beds; and these, owing to the highly-disturbed condition of the strata, must be in a considerable degree crushed and faulty, as at Nathan Beach's Mines, at the base of the mountain, rising from the river. Along the River Road the Umbral red shales are well exposed in a shallow double synclinal flexure.

The central elevation here is called the Southern Hog-back. As we ascend the face of the stony ledge, the dip of the conglomerate rocks increases, being at Beach's upper drift 35° N. The coal-bed opened here is so crushed that its true thickness could not be properly estimated.

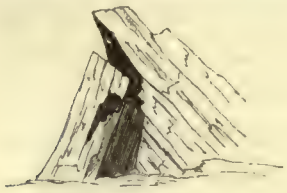


Fig. 297 (*b*).

Fig. 297 (*a*).

About 100 feet from Beach's upper opening, to the N., there occurs a sharp roll (diagram *a*), in tracing which up to the top of the mountain, the dips, especially the N., are seen to increase, becoming 70°, and the whole flexure is sharply broken, as in the sketch *b*; the rocks are coarse-grained pebbly sandstones, and perhaps underlie the coal. The flexure is traceable some distance W. As we proceed toward the termination of the coal-field these flexures appear more frequently, and the strata everywhere exhibit evidence of great disturbance.

The Seral conglomerate is sometimes observed far down the flank of Stony Ridge. The Vespertine shales occasionally occupy the entire summit of the Nanticoke Mountain. The strata of Stony Ridge, or the S. rim of the terminal basin, are evidently more disturbed and contorted than those of the Nanticoke Mountain, forming its N. dip; and this is true of the Wyoming Basin as far E. as Wilkesbarre.

The following section, made about a mile W. of the river, shows the numerous undulations in which the basin ends. Here Stony Ridge or Little Mountain is entirely occupied by the Seral conglomerate and overlying Coal-measures; the former appearing in a most unusual place—that is, nearly in the bed of the valley. Whenever, on the N. side, the Umbral shales spread over the entire summit of the Nanticoke Mountain, the Coal-measures extend in a succession of waves over the intervening space. Coal has been opened by Mr Jamieson on the line of section, but cannot occur much further W.

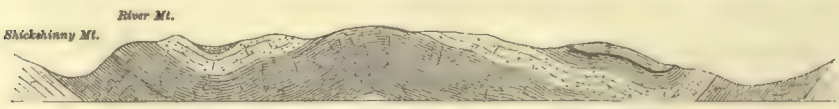


Fig. 298.—Section across the Coal-basin at its Western End.

The flexures, short and sharp, which have been so often described, also occur beyond the limits of the coal. One such is seen at the falls of the Shickshinny Creek, in the rocks of the Vespertine sandstone.

Iron Ores.—Among the Coal-measures of the Wyoming Basin, beds of iron ore of proper size for mining have not been discovered; occasionally thin beds are found, but not of sufficient thickness to be valuable. The only iron ore as yet mined to any extent occurs in the rocks

underlying the Seral conglomerate. The mines have been opened on the S. side of the Lackawanna Valley, about 6 miles above Pittston. The ore is found near a little stream called the Meadow Run, which empties into Roaring Brook. Its position is in the greenish buff sandstones marking the transition from the Vespertine shales to the Seral conglomerate. These strata must be here of considerable thickness ; the Vespertine red shale is not apparent near the mines.

The ore, interstratified with the sand-rocks, dips more than 10° N.W. The thickness of the vein varies ; in one drift, near the entrance, it was 1½ feet thick, increasing to 2 ; in higher drifts its thickness was 3 feet, increasing even to 4. Above the ore is fire-clay, in which, in some places, are found imbedded large balls of ore, through a thickness of perhaps 1 foot.

An impure limestone is found not far from the ore, in the same series of rocks.

(For a more precise description of this iron ore, see account of the Iron Ores of the vicinity of Scranton, p. 357 of this volume.)

CHAPTER VI.

WYOMING, KINGSTON, AND PLYMOUTH DISTRICT.

THE last district of the coal-field which remains to be described, is that embraced between the Shawnee Mountain and the river Susquehanna, from its entrance into the basin at the mouth of the Lackawanna, to its exit at the Nanticoke Notch. More than one-half of the area of the Coal-measures included within this district is occupied by a deep, and hitherto an almost unpenetrated, superficial stratum of diluvial drift, the depth of which has been probed only in one or two spots. In the present unexplored condition of this large and valuable portion of the basin, it would be idle to attempt any conjectures respecting its underground structure, or the positions of the coal strata within it, beyond perhaps the inference that several of the more persistent and bolder anticlinal undulations of the Pittston district to the S. of it must penetrate it, or even nearly cross it, before they altogether expire. From a study of the structure of the Pittston district, we are perhaps warranted in assuming, moreover, that the coal strata beneath these flats are, on the whole, less undulated or disturbed than in the district S. of the river, between the Lackawanna and Wilkesbarre.

The anticlinals which do exist are probably prolongations of those of the Pittston district, and not of the set emanating from the N. side of the valley.

At what depth the Coal-measures are to be reached below the surface of these Wyoming and Kingston flats remains to be ascertained, but borings now in progress and in contemplation will soon settle this question. I deem it probable that the drift stratum has in many places, if not generally, a thickness of at least 100 feet.

I pass now to the consideration of the structure of that part of the district which lies between the diluvial flats and the conglomerate border of the Coal-measures on the Shawnee Mountain.

Monoclinal South-dipping Belt of Strata between the Pittston Gap and Hertzoff's Hollow.—This is a narrow strip of Coal-measures in but few places exceeding half a mile in breadth, extending from the edge of the flats at the foot of the mountain to the final outcrop of the Coal-measures which rise to various elevations on the mountain, dependent on the local erosion of its surface.

This mountain-limit of the coal recedes gradually from the flats as we advance W., being not more than a fourth of a mile N. of them opposite Pittston, and about three-fourths of a mile as we approach Kingston. The actual line of outcrop traced in detail will be found to be an undulating or scolloped line, sweeping highest on the mountain in the space midway between each cross ravine, and descending both ways to a point into each notch or hollow.

We have defined this belt as one of monoclinal structure, and such it essentially is, no notable undulations occurring within it; nevertheless there are probably—more especially towards its W. limit—some very gentle undulations of the dip, scarcely amounting to an actual reversal in direction, but merely to a flattening of the prevailing S. pitch. These will manifest themselves hereafter, in the progress of mining.

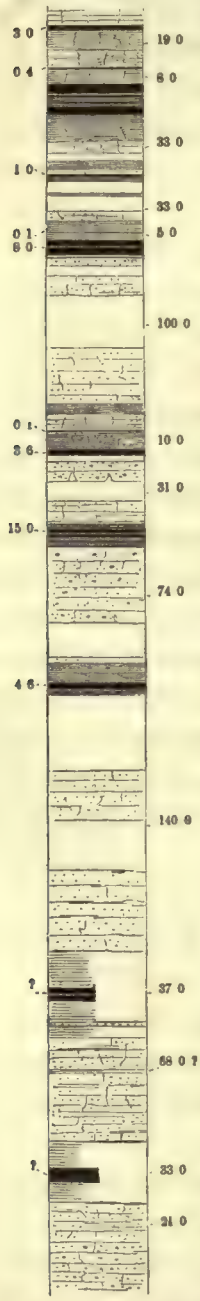


Fig. 299.—Column of Coal-measures visible in Shoemaker's Ravine, N. of Kingston.

OF THE COAL-BEDS HITHERTO DISCOVERED IN THIS BELT.

The accompanying vertical section, compiled chiefly from observation in the ravine N. of Kingston, and along the mountain to Hertzoff's Hollow, represents what is at present known respecting the coal-seams of this belt. Those represented hypothetically toward the base of the column were opened many years ago on Toby Creek by Mr Raub. They are represented under their most favourable thicknesses in the cut, (Fig. 299.)

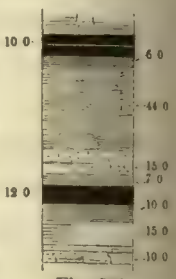


Fig. 300.

Excepting these lower seams, which occupy a position low down in the series, our section represents only three, or at most four, seams of valuable thickness, and the range of these is such, that they have not yet been mined very extensively. They were observed many years ago, when freshly opened, in Shoemaker's Ravine.

The two upper workable seams, dipping about 35° S., are subdivided as follows:—

Coal, 6 feet 6 inches; black slate, 12 inches.
Coal, 6 inches.
Coal and carbonaceous shale, 2 feet; black slate, 2 feet.
Coal, 1 foot; shale, 2 feet.
Coal, 5 to 6 feet.

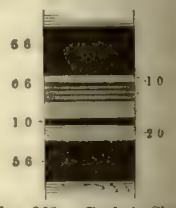


Fig. 301.—Coals in Shoemaker's Ravine.

On the other side of a narrow synclinal trough there is a change in the intervening measures, as the section will illustrate.

The poverty of workable coal-seams in the lower part of the formation is quite striking; the more so, when we contrast it with the abundant size of the great coal-stratum in the same horizon, traceable, as we shall see, from Nanticoke Gap almost to Hertzoff's Hollow, and when we advert to the magnitude of the lower beds on the opposite side of the basin S. of Wilkes-barre. It is only to be explained by supposing, what so many facts in the comparative geology of the lower Coal-measures suggests, that the main great bed, in its distribution N., either becomes rapidly

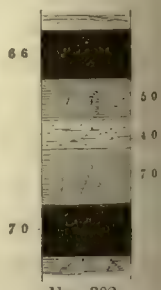


Fig. 302.

exhausted by actual thinning, or subdivides, and loses its identity, by the parting asunder of the several tiers or benches which constitute it a compound mass, where it is thickest. If our identification be correct, the mass of coal and slate represented in the section as 15 feet thick, and analysed in the accompanying woodcut, is a confirmation of this view.

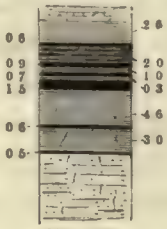


Fig. 303.

In like manner the large Plymouth Bed, traced E. to Toby Creek, seems to have dwindled down to no more than 9 or 10 feet.

Iron Ores.—In Hertzoff's Hollow, or the gap N. of Kingston, and in the Vespertine series, between 500 and 600 feet below the Seral conglomerate, two bands of iron ore have recently been developed. They are included within a mass of olive ferruginous shale, which occupies the interval between two heavy ledges of conglomeritic sandstone. The ore is black, ponderous, and very silicious ; indeed, the mass might be termed a fine conglomerate, the pebbles of which are cemented together by the ferruginous paste that constitutes the ore. As thus far proved, the upper bed measures from 2 to 3 feet, and the lower upwards of 4. They are separated by 5 feet of hard rock. From the irregularity of shale floor and roof, the thickness of the bands, it is thought, will prove variable.

Limited quantities of the ore have been transported to Danville, and smelted with profit.

The Plymouth Belt, or that extending from Kingston to Nanticoke Notch.—In the interesting division of the coal-field now before us, the maximum breadth of which at Ross Hill a little exceeds one mile and a half, we have a district remarkable for the gentleness of its dips, and consequently for the long breasts of coals which it includes above the water-levels of its intersecting valleys. It embraces some seven or more discernible anticlinal undulations, two of which are long, and rather conspicuous ones ; but the influence of even these is trivial in interrupting the very general prevailing Southward inclination of the strata. This gentle dip of the Coal-measures towards the river permits the working of long breasts of coal towards the mountain, and facilitates greatly the transport of the coal over gently-descending grades, and allows it an outlet by tunnels to the adjacent navigation : it is a feature in the structure of this district which confers upon it almost pre-eminent mining advantages, reminding us, on a small scale, of the facilities enjoyed by many portions of the great basin of South Wales, the largest coal-field of Great Britain.

I proceed to define the situation of the flexures hitherto detected in this district.

Undulation A *of Belt* 20, *or Plymouth District.*—This is a local undulation in the strata, visible near the intersection of the road leading N.W. from Kingston, over the mountain, and Schupp's Creek. It is marked by decided N. dips, visible on the road as we commence the ascent of the mountain N. of the stream, the inclination amounting to perhaps 20°. This is soon followed, however, by the prevailing S. dip, as we enter the strata which include the two lowest coals, or Hoyt and Jaquish's ; it is therefore obvious that the flexure is one of trivial influence. How far it extends E. and W. of the road cannot be ascertained till mining develops it farther. So extensive is the covering of drift upon the hills of this side of the valley, that the tracing of these lesser axes by merely surface-marks is an almost impracticable task.

Anticlinal B *of Belt* 20, *or that of Gaylord's Mine on Pine Swamp Run.*—The next flexure which arrests our attention in this part of the coal-field is a flat undulation, visible just at the mouth of the old Cooper Mine (now Gaylord's). This lies a short distance within the mine,

and, as it is subsiding Eastward, has the effect of curving the gangway, which is now running N.E. out of its proper course, somewhat more Eastward, and then back again. Its effect, however, is trivial.

Anticlinal C *of Belt* 20.—About 500 feet S. or S.E. of the mouth of Gaylord's Mine, another rather more considerable flexure crosses the same valley, between Gaylord's Mine and Levy and Patton's. The effect of this is to lift out the upper or Cooper coal of the neighbourhood from below the water-level of the stream, and to produce the N. dips a little in front of Gaylord's Mine. Some vestiges of this anticlinal are discernible on the by-road leading from the mines to the road running N.W. from Kingston. We detect this anticlinal to the Westward of the stream in Levy and Patton's Mine, not far from their old gin-slope, where its effect is to elevate the Bennet or Patton Coal, that next beneath the Cooper bed, almost to the surface.

Flexure D, *or that of the Mouth of Levy and Patton's Tunnel.*—A trivial flexure occurs just within the mouth of Levy and Patton's tunnel, producing a perceptible dip Northward in the strata; of the extent and the effects of this we know very little.

Anticlinal E, *or that of Wadham's Mine.*—We have next to consider a flexure of more length and apparent importance than the four above enumerated. It is one which seems to come off, like the others, obliquely from a high point on the flank of the mountain, and is traceable in a straight course for some two miles as far Eastward as the cross road leading from Schupp's Creek northward towards the mines. This axis, nowhere accompanied by steep dips, is barely discernible on the cross road mentioned, and seems as if this were its commencement or termination. It is seen in its greatest distinctness on the little stream which flows by Wadham's Mine, N. of Plymouth, and again on Smith's Creek farther Westward. At Wadham's, the whole breadth occupied by the flexure is very small, its N. dips not occupying a space of more than 100 feet, and 20° or 30° being the extent of the N. dip; from which it may be seen that the effect of this upward flexure of the rocks on the distribution of the coal is trivial. It nevertheless has the effect of separating the first outcrop of the Cooper or Orchard Bed from the lower outcrop of the same seam, worked at present by Wadham in the basin N. of it on its second Northward rise.

On Smith's Creek this axis is somewhat more conspicuous. It there embraces a double wave, a Southern and wide undulation, apparently the principal one, and a Northern and sharply compressed flexure, showing both dips with a steepness of 80° over a very narrow space.

The effect of this anticlinal on Smith's Run is to lift out what is there called the Reynold's Coal, or the seam next above the great lowest bed, or that of Smith's Mine, and to leave it no space to basin again farther N. This Reynold Coal, being apparently the equivalent of the Bennett or Patton Coal, or the seam next under Wadham's—the equivalent of the Cooper or Orchard bed—it is plain that the axis in thus lifting it out has continued to rise, in its Westward course, from the neighbourhood of Wadham's Mine. How far it ranges to the Westward of Smith's Run has not been ascertained.

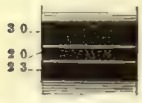


FIG. 304.—Reynold's Small Bed on Smith's Creek.

Anticlinal F, *or that S. of the Basin of French's Tunnel.*—Succeeding the axis of Wadham's Mine, and situated about 1000 or 1100 feet S.E. of it, ranges another much longer parallel anticlinal wave, traceable from N.E. of the village of Plymouth to the Mountain-notch of Nanticoke. This is an important flexure in all the mining ground W. of Smith's Creek; our first or most

Eastern indications of it are on the W. side of Gaylord's Railroad, half a mile N. of the turnpike, where the arch is distinctly discernible in a small railroad cutting, but where the N. dips, however, are of very limited breadth. From this point to Smith's Run it is only obscurely visible; but a little W. of that ravine it becomes conspicuous in the topography, and begins to manifest itself as a prominent though narrow flexure. It first enters the Southern protuberance on the S.E. slope of the main hill next N. of the turnpike road, and then ranges along the crest of this hill, displaying a beautiful and symmetrical arch at the ravine running S. from French's Tunnel, arching the rocks in fact the whole distance to Lance's upper mines, and to the deep notch in the end of the mountain N.W. of Harvey's. Increasing in steepness from Smith's Run westward, it exhibits a N. dip of 60° at French's Run, and an almost perpendicular one N. of the Grand Tunnel; while beyond the latter point, as we enter the narrow defile in the end of the mountain, it appears to pass into an actual dislocation, obliterating altogether its Northern dips, and causing the South-dipping strata of the N. side of the basin N. of it, and a large patch of the lowest or Big Coal, to abut violently where the axis should be, against the rocks composing the S. leg of the broken arch. From the hill W. of Smith's Run to the head of the gorge containing the dislocation, the basin N. of this flexure is a very regular and symmetrical one, characterised, however, by much gentler S. dips than N. ones.

It is on the N. side of this little basin that French's short tunnel perforates the sandstones overlying the lower or great coal-beds, and it is likewise on the same S. dip or upper outcrop of it that Lance's upper mines are seated on the Grand Tunnel property. And it is likewise in the same general strike, and on the same side of the same synclinal, but replaced here by a prodigious fault, that the large insulated patch of the Big Coal occurs on Harvey's property, near to the Western end of the mountain, in the knob overlooking the ravine. Throughout the entire course of this anticlinal, as it gradually rises Westward until it approaches its points of dislocation, the great or lowest Coal-bed nowhere rises out to the surface, but is oversaddled by the next higher rocks. It is not until we reach a point about due N. of Harvey's Tunnel that the denudation and the Westward rise of the anticlinal combine to remove these overlying strata, and to expose to view the large coal upon the anticlinal axis. Elsewhere, in order to enter that portion of this coal which basins to the N. of the anticlinal line, it will be necessary to tunnel into it from points lower down the hill, selected at such elevations on the S. side of the anticlinal flexure, as by calculation will just carry the tunnels to the synclinal part or deepest centre of the trough.

Anticlinal G, *or that of the S. Edge of Ross's Hill.*—A feeble flexure is traceable along the Southern edge of Ross's Hill south of the main road, and adjacent to it. It is the cause of the N. dips seen on that road E. of Schupp's Creek; and it may be detected in a corresponding Northern dip farther Eastward in the bluff of the hill S. of the road.

It does not seem to cross Schupp's Creek, or at least no considerable flexure has hitherto been detected in the Gould Coal-bed in Shunk's mine W. of that stream.

COAL-MEASURES AND WORKABLE COAL-SEAMS OF THE PLYMOUTH DISTRICT.

In the district before us there would appear to be four workable beds of ample dimensions for mining, and one, and sometimes two of these, are of unusual size.

1*st*, *The Plymouth Great Bed.*—The first or lowermost in the series is the Great Nanticoke

Bed. This at Harvey's, and at Lance's Grand Tunnel Mine, the two most Western of the district, has a total thickness of about 22 feet, yielding in the first-named mine about 12 feet of coal, and in the other a total of 17 or 18 feet. At Smith's Mine, nearer Plymouth, the whole thickness of the compound seam is a little more than 17 feet; while, by the time it reaches Jaquish's, on the road N.W. from Kingston, though still further reduced, it retains the dimensions of an ample bed.

(An inspection of the several sections of this Coal-bed, as it exists at the chief localities, will best show its composition and the changes which it undergoes.)

At Harvey's Mine, where the great bed crops out from under the continuation of Thomas's sandstone bluff, the bed dips 15° S., and is from 18 to 20 feet thick; over it is slate 3 feet thick, on which rests a dark-grey, fine-grained, micaceous sandstone, 18 inches thick; and over this, coarse sandstone and fine conglomerate. Coal was taken from this mine more than twenty-five years ago. The present mouth of the mine is at water-level at the level of the road. The gangway runs N.E., and there are thirty-six breasts in the mine from the lower gangway to the outcrop; these are each 25 feet wide, and the average width of the pillars is 14 feet. The whole length of the breast of coal to the outcrop must be half a mile; the length of the gangway was (in 1854) 1450 feet. The subdivisions of the seam are,—

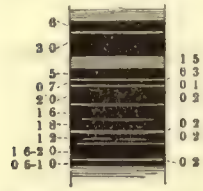


FIG. 305.—Great Plymouth Bed, Harvey's Mine.

Coal, 1 foot 6 inches; Slate, thin; Coal, 3 feet; Slate, 17 inches; Coal, 1 foot 5 inches, pyritous; Slate, 3 inches; Coal, 7 inches; Slate, 1 inch; Coal, 2 feet, poor; Slate, 2 inches; Coal, 1 foot 6 inches; Slate, thin; Coal, 1 foot 6 inches; Slate, 2 inches; Coal, 1 foot 2 inches; Slate, 2 inches; Coal, 1 foot 9 inches; Slate, 2 inches; Coal, 9 inches.

Big Coal in Lance's Grand Tunnel Mine.—The upper bench has from 12 to 13 feet of coal in all, but the lower and upper parts are the finest, and the average amount of good coal is 10 feet.

FIG. 306. — Plymouth Big Bed, Lance's Grand Tunnel.

Slate, from 1 to 2 feet; coal, having a dull lustre, yielding a red ash, and breaking with a conchoidal fracture, 8 feet.

2*d*, *Bennett's or Patton's Coal-bed.*—The second coal in the series, known near Plymouth as Bennett's or Patton's, is usually situated about 55 or 60 feet above the lower great seam, the space between them probably enlarging as we go Eastward. The usual thickness of this bed N. of Plymouth is about 10 feet; but the equivalent seam farther Westward in the district, in the neighbourhood of the Grand Tunnel, has a thickness of 5 feet. In the intermediate ground on Smith's Creek, this seam, there called Reynold's, possesses intermediate dimensions, having a thickness of about 7½ feet.

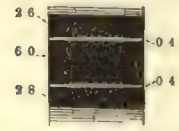


FIG. 307.—Levy and Patton's.

Bennett and Patton's Mine worked from the Tunnel.—The tunnel is about 300 yards long; at its mouth the Cooper (Orchard) Coal lies 12 feet below the surface. The tunnel passes this bed, then rock for 200 yards, and then reaches the Bennett Coal. The dip is very gentle. The benches in Bennett's Coal are,—

Slate and Coal-slate, 2½ feet; Stony Coal, 3 feet; Pretty good Coal, from 4 to 4½ feet; Slate, 2 inches; the best Coal, 3 feet.

3*d*, *The Cooper or Orchard Bed.*—Overlying the second coal-bed, by an interval varying according to the neighbourhood from 40 to 60 feet, is a third bed, generally called Cooper's, believed to be identical with the so-called Orchard Seam, N. of the village of Plymouth. This coal-seam is about 6 feet in size in the neighbourhood of the Grand Tunnel; at Wadham's it is

$7\frac{1}{2}$ feet thick, and in Orchard's Mine 8 feet; but at the Old Cooper Mine, 1 mile further to the N.E., it measures in all 10 feet, though some distance back in the mine it is a foot thicker, and there yields at least 9 feet of good coal. (See its subdivisions in the cut, fig. 309.)

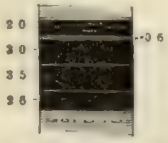


FIG. 308.—Gaylord's Coal, Cooper Bed.

The Cooper Coal, Pine Swamp Run.—This mine is a regular pillar and breast-work mine, its roof being supported entirely by pillars of coal. The "board and head" are quite well marked in the mine. The coal is 10 feet thick. The top is slate, laminated.

Coal, 1 foot 6 inches; Slate, 6 inches; Coal, 3 feet; Fine Blacksmith's Coal, from 3 to $3\frac{1}{2}$ feet; Short Coal, from 2 to $2\frac{1}{2}$ feet.

Blue clay-slate, with large flat balls of iron ore.

The underlying slate and shale are quite thick. The Cooper coal burns freely, and is yet an excellent enduring fuel.

An anticlinal axis, wide and flat, passes just through the mouth of the Old Cooper Mine, and swings the roadway a little to the Eastward and back again Westward.

There is an anticlinal about 1000 feet S. of the crossing of the two railroads.

4th, The Gould Coal-bed.—Next above the Orchard Seam lies the Gould Bed, though many persons have supposed the two beds to be identical. This seam appears to be restricted to Ross's Hill and the knob next W. of it, and not to cross the valley of Cooper's Creek or the Pine Swamp Run. It is at present mined from the water-edge at the river, just W. of Schupp's Creek, in the Rudmund-dale Colliery. This bed has an average thickness of 6 feet, yielding that much of good coal, excepting a 2-inch layer of slate in the middle. The quality of the coal is excellent.

Gould and Shunk's Mine.—At the mouth of Schupp's Creek, or Rudmund-dale, this coal has been wrought languidly for thirty years. The coal dips gently S.E.; it just comes down to the edge of the ravine at the mouth of the mine, and is 43 feet below the bed of the Creek at the crossing of the main road. This coal has an average thickness of 6 feet, and yields all coal except 2 inches of slate in the middle. Its divisions are as follows,—

Slate Roof; Rough Bird's-eye Coal, 3 feet; Good clean Coal, 3 feet; Excellent Coal, 1 foot; Slate Bottom.

The only gangway is at the water-level, and runs N. 60° E. for about 35 rods (600 feet). The coal is sent to market chiefly in lump form, and is used in iron furnaces. The outcrop of this coal crosses the road 200 yards E. of Culver's house in Plymouth. The outcrop of the 6-feet bed is also seen at Schupp's Creek. The upper limit of it on the hill is about 1300 feet N. of the road from the mine.

Mr Dodson is working the outcrop of the "Big Coal" at the foot of the mountain, and the middle coal has been opened on its outcrop 600 feet S. of it.

On Nesbit's property, E. of Gaylord's Railroad, the second coal, 7 feet thick, contains checked or bird's-eye coal of good quality.

The *boring* on Mr Gaylord's land in Plymouth begins in the floor of the Orchard or 8-feet Upper Coal of this vicinity. It is supposed to be the Cooper Coal, though distant a mile from it. The following is a section of the strata met with,—

Cooper or Orchard Coal, 8 feet; Soft Sandstone, containing a little slate, 63 feet: within the sandstone is,

a bed of coal, 1 foot thick ; Patton and Bennett's Coal, 10 feet ; Supposed bottom coal—but this is doubted 12 feet, soft.

Pebbles and dirt generally underlie the Big Coal ; therefore the soft floor here is thought to prove that this lower bed is not the Big Coal.

The Avondale Tunnel is at present (1854) 155 yards long. It intersects two thin coal-beds. The first is a bed of heavy hard coal, from 4 to 5 feet thick ; the second, a bed one foot thick, but called 3 feet, and supposed to be the same as the 3-feet Coal *over* the Grand Tunnel mouth.

Watham's Coal, or Bennett's Coal on Watham's Creek, is worked N. of the anticlinal axis. This coal is 7½ feet thick, rather rough, but well adapted for smelting iron. The benches are,—

Sandy slate ; Good Coal ; Slate, 2 feet ; Good Coal, 2 feet 6 inches ; Slate, 7 inches ; Good Coal, 3 feet ; Shale.

The Tunnel is bored 30 yards into the coal ; the gangway runs E. and W. ; the dip, after passing in a little way, is very flat to the S.

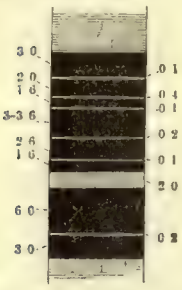


FIG. 309. — Reynold's (Smith's) Great Bed, 1 mile N. of Reynold's Tunnel.

Outcrops of the Coals.—The lines of outcrop of the four coals above described will be best understood by inspecting the Geological Map of the region. That of the large lower coal follows the bold outcrop of the Seral conglomerate, keeping a few hundred feet S. of it, winding a little in its course in virtue of the two or three flat anticlinal undulations which run obliquely off from the crest of the mountain, but deviating from a straight course chiefly from the influence of erosion, which swings the margin of the coal in every case S. into the beds of the ravines, and back again N. upon the water-sheds which separate them. The outcrops of the three next overlying coals are much more devious, in consequence of their greater and more complex displacements of level, by the lesser anticlinals already described as traversing them.

The following sections will assist to illustrate the undulations and places of outcrop of the coals in the vicinity of Plymouth.

FIG. 310.—Section on Smith's Creek, W. of Plymouth.—1 *inch* = 600 *feet.*

FIG. 311.—Section from Conglomerate by Gaylord's Mine, N. of Plymouth.

Upper Coal-beds.—There are probably two or more thin upper coal-beds above the Gould Bed, in the S.E. part of Ross's Hill, but of these we know at present extremely little, as they have not been developed by mining, and are not easily traceable without it ; the thickest of them has been penetrated in one or two spots just N. of the main road, and appears to be between 3 and 4 feet thick ; but what extent of surface it underlies has not been ascertained.

APPENDIX TO BOOK VIII.

BEING A REVISION OF PORTIONS OF THE SOUTHERN ANTHRACITE COAL-FIELD.

THE following notes embody the results of an examination of all the collieries of the Southern Coal-field W. of Tuscarora, from which coal is at present mined, or may probably be mined in 1858. They bring the information down to the month of April of that year, and are more precise, therefore, than the memoranda embraced in the foregoing pages. In the chapters devoted to the description of the Pottsville Basin, special stress is laid upon the necessity of a full and complete understanding of the many anticlinal and synclinal flexures of the strata. Inferior importance is attached to the exact extent which a mine may have, or indeed to any features which do not throw some light upon the structure of the region. Our notes relating to the Collieries were in most cases obtained from the head miners, and are somewhat desultory and imperfect.

In collecting the information here presented, great care was taken that the data should be, as far as possible, correct. Recourse was had usually to some intelligent person connected with each mine, and, in a large majority of instances, also to the working plans. These sources, checked by our own observations and measurements, make the statements full, and, we think, precise, enabling us to point out some errors in previously expressed opinions, and to give many new facts, which the progress of mining in the district has brought to light.

TUSCARORA.

Tioga Colliery (page 108 of text) — Graber and Wagner, lessees; one-fourth of a mile E. of Tuscarora.—This mine has a slope, sunk 100 yards below water-level, on the Doherty or Jackson coal-seam—dip, from 50° to 65° S.; gangways are driven 600 yards E., and 300 yards W. From the foot of the slope a tunnel is cut 75 yards S. to the Stapleton Bed, upon which gangways are driven 150 yards E. and 30 yards W. A tunnel is driven N. from the gangway 50 yards E. of the slope, to a seam locally termed the Primrose Vein, dipping 45° S. Upon this bed gangways are opened 116 yards E. and 25 yards W.

The Jackson Seam, when undisturbed, will yield from 5 to 6½ feet of coal, but it is much pinched and crushed. It is the only seam now wrought at the colliery. The Stapleton Bed is very irregular, and subject to dirt-faults; it varies from 2 to 10 feet in thickness. The Primrose Seam, though stated to be 18 feet thick, has not yielded a ton of sound coal. It appears to be a mass of crushed coal and dirt, and 75 yards on the breasts above the gangway it is entirely pinched out.

Yield, in 1857, 14,612 tons.

Palmer's Tunnel (page 103 of text)—A. Sillyman, lessee (formerly, C. Sillyman).—A section representing the seams cut in this tunnel is already presented in an earlier chapter of the book (p. 106). We need only here notice the extent of the gangways. The *E.* Coal-bed is worked 250 yards E. of the Tunnel, and 2250 yards W.; its normal thickness is 18 feet; but 850 yards W. of the Tunnel it is supposed to be subdivided by the interpola-

tion of a stratum of rock. The upper portion of the bed, 7½ feet thick, is mined forward. No attempt has been made to discover the true cause of the sudden diminution in thickness of the bed.

The Palmer Seam is mined 250 yards E.; driven 570 yards W. The coal was found abutting against a vertical wall of rock; along this the bed is shifted N., the bottom slate observing a gentle S. dip, whereas the top stands nearly vertical. The line of intersection of the two slates rises W. towards the surface, as has been proved by mining. The Palmer Bed has been traced on the surface 160 yards W. of the fault, but every attempt to follow it further has failed. The seam averages 10 feet of good coal.

The Bony, or Rough Seam, is mined 200 yards W. The bed contains from 8 to 16 feet of coarse bird's-eye coal.

The Grier Bed, driven 400 yards W., is nipped out by the approach of the top and bottom rocks; an upper level encountered the squeeze 160 yards further W. It is not now wrought, but its average thickness of good coal is 6 feet.

The shipments of coal in 1857 amounted to 32,318 tons.

Sillyman and Myers' Slope, and George H. Potts' Slope on Big Creek, were both abandoned in 1857.

Beechem's Upper Tunnel (page 110 of text)—R. Gorrell, agent.—This tunnel, entering Southward into Sharp Mountain intersects four seams of workable dimensions locally designated the O, P, Q, and the QQ, the several beds containing, according to the manager, 4½, 5, and 3 feet respectively of coal suited to the market. The only bed now wrought is the P seam, which is driven 700 yards E. and W. until it degenerates to dirt. The other coals have either been mined to the boundary of the property, or are too much crushed and irregular to be mined with profit. In 1857, 8559 tons were sent from the mine.

MIDDLEPORT.

Milford Colliery (page 113 of text)—J. Jones & Co., lessees (formerly S. Sillyman).—The information gathered in 1853 regarding the Milford Tunnel seems to have been imperfect as respects the distances between the seams. We are now possessed of the results of a correct mine survey.

The old Milford Tunnel is driven Southward 1410 feet to the Palmer coal-seam dipping steeply Northward. This tunnel was begun near the outcrop of the C. Pott Bed at water-level, and intersects the Palmer Seam, dipping S. 400 feet from the mouth; the Spohn, a thin leader, at 580 feet; and the Spohn leader of coal dipping steeply N. at 1270 feet. The gangways worked Eastward on the two dips of the Palmer seam converge 1650 feet from the tunnel. From the S. gangway of the Palmer, 420 feet E. of the main tunnel, a tunnel is cut Southward 160 feet to the sandstone seam, a thin bed dipping nearly vertically N. It is followed 950 feet E., and a third driven Southward intersects the rough seam at 175 feet; the C. Pott at 215 feet, and the Clarkson at 435 feet, all standing on end. The sandstone and the rough seams are not represented by any stratum of coal in the main tunnel at the N. side of the basin. The only seams now wrought at the colliery are the C. Pott, 2 or 3 feet thick, and the Clarkson, 5 feet thick. Upon these, gangways are driven a fourth of a mile Eastward.

The Milford Slope sunk on the Clarkson Seam, 1000 feet N.E. of the tunnel mouth, is now abandoned. From this slope the Clarkson was mined 650 yards E. and 425 yards W. The E. gangway encountered a "rock squeeze" of the coal, which ranged across the breasts 20 yards above the gangway. By a tunnel 55 yards long the C. Pott coal seam, overlying the Clarkson, was reached, and mined below water-level 225 yards W. and 260 yards Eastward.

The shipments in 1857 were 4303 tons.

Middleport or South Basin Colliery (page 115 of text)—Lessee, J. G. Bryce, (formerly Neville); Agent, H. C. Brooke.—The tunnel at this colliery enters Northward into Silver Hill, a distance of 20 yards, to a bed of coal, the precise equivalent of which has not been determined. It dips Southward at an angle of 20°. The coal is squeezed and faulty, for which reason the gangway to the Eastward was soon abandoned. West of the tunnel it was followed round the point of a declining saddle, upon the N. side of which the dip rises to 70°, and the coal is sound and good. Its thickness in the present workings averages 6 feet, though it sometimes exceeds this. There are no dividing-slates in the bed. The main gangway is 1100 yards long—ash, pink.

Yield of the mine, in 1856, 14,421 tons; in 1857, 14,704 tons.

A mile E. of the preceding a shaft was sunk upon a vertical coal-bed to a depth of 100 yards. From this level gangways ranged E. and W. a few hundred yards. The coal is 8 feet thick. It was worked only a few months in 1857 by Mr S. Chadwick, and is now temporarily abandoned. It yielded, in 1857, 1633 tons.

Five hundred yards S. of the shaft, Mr Bryce has recently opened a coal-bed 5½ feet thick, dipping from 60° to 65° Northward. The drift has advanced 180 yards.

CASCA WILLIAM VALLEY.

Northdale Slope Colliery (page 108 of text) — lessees, Luther, Daniel, and Gabel (formerly Rogers, Sinnickson, & Co.)—This mine is situated upon the Big or Raven coal seam, where it outcrops upon Mine Hill at the head of Casca William Valley. The prevailing subdivisions of this great White-Ash bed are as follows:—

Shelly Coal, 3 feet; Slate, 2 inches; Hard Coal, 7 feet; Slate, 6 inches; Hard Coal, 5 feet; Slate, 18 to 10 inches; Hard Coal, 4 or 5 feet.

At times the bed swells out to a thickness of 50 feet; but such enlargements are almost always followed by a corresponding diminution. It shrinks to 10 feet, and in one place to 7 feet thick.

The slope follows the bottom slate of the coal at an angle of 55°. Its length to the water-level gangways is 45 yards; to lower gangways, 100 yards farther. The water-level gangway is driven Eastward 1400 yards; a tunnel cut Northward into the mountain reached the coal 400 yards E. of the slope. The W. gangway at water-level is mined 650 yards. On the lower level the E. gangway is 120, and the W. 350 yards long. These gangways observe their proper course N. 70° E., and S. 70° W. In the W. workings of the lower level a crushed or faulty condition of the coal, commencing 20 yards W. of the slope, extends Eastward to the end of the E. gangway. The upper line of this "dirt" fault dips Westward 20°; it therefore crosses the slope, and affects the coal in the E. water-level gangway. The colliery is temporarily abandoned; but the obstacle opposed to profitable mining by this fault is thought to be nearly overcome.

In mining the coal from the breast between the levels, rectangular chambers 12 yards wide are cut away, leaving intermediate pillars of coal 6 yards wide to support the roof. These pillars are abstracted when the level is abandoned, and the roof falls in. In order to protect the slope-way of the mine from injury, pillars 40 yards wide are left on either side.

The old water-level *Tunnel* above alluded to is 546 feet long to the Big Coal, the gangways upon which drain off the water. The tunnel cut a coal-seam 8 feet thick, known as the Black Valley bed 207 feet S. of the Big seam. Three small coals were passed between this and the mouth. None of these have been mined.

Raven Slope, Casca William Colliery—(Luther, Daniel, and Gabel).—The old workings comprised a water-level gangway W., and a slope-level with gangways E. and W. The water-level gangway or drift was mined 775 yards W. to the property line, and is now abandoned. The old slope (exhibited in the Casca William section) was located on the sharp anticlinal Axis (D) of the Big or Raven Coal over the E. end of the South Mine Hill Axis. It followed the bottom slate of the coal, descending Southward at an angle of 61° a slope length of 270 feet. The coal then became flat, and rose with an opposing dip to roll over again into S. dip, thus forming a basin 50 feet wide, and an anticlinal arch, which was passed through by a tunnel 90 feet long. The gangways in the basin were mined W. 775 yards. The E. gangway was driven 175 yards, when it began to warp Northward round the declining anticlinal on which the engine-house stands. At 200 yards' distance from the slope the level was abandoned. From the S. end of the tunnel the W. gangway, 185 yards long, swept round the end of the little anticlinal roll, and connected with the main gangway W. from the slope. The E. gangway started from the tunnel on coal dipping 29° S.; but the saddle declined E., and the basin rose, so that the two merged into a nearly flat dip. The gangway swung Northward, and was abandoned: it is 150 yards long.

The new Raven Slope descends through sandstone at an angle of 52°, to intersect the Big Coal at the South end of the tunnel from the old slope. It is 120 yards long to the tunnel level. It then follows the coal 102 yards below the tunnel-level at an average angle of 60°. At this lower level the W. gangway is driven 350 yards in the normal bearing. The E. gangway, 75 yards E. of the slope, deflects S. round a feeble basin, and

again turns E. It will, no doubt, eventually deflect N., parallel to the old levels above. The length of this gangway at present is 260 yards.

The great bed mined at this colliery exhibits the same character, subdivisions, and average thickness, which we have noted in describing the Northdale Slope.

The *Black Heath Coal-bed,* lying next above the Big Seam, has been mined above water-level only. It is 9 feet thick, including an 8-inch band of slate 5 feet from the top. The ash is pink.

The *Black Valley Seam* next succeeding has not been mined below water-level. It is a pink ash coal, 7 feet thick, divided by 1 foot of slate 4 feet from the top. The proprietors propose erecting a slope colliery upon one or other of these beds.

The *Luther Slope Mine,* belonging to the same estate as the preceding collieries, is located upon the Luther or Diamond Coal-bed, which averages 6 feet in thickness; top bench, 4 feet; slate and dirt, 6 inches; bottom bench, 18 to 36 inches.

The slope descends along the bottom slate 90 yards, at an angle of 50° to the first level. The dip thence gradually declines to 26° at the lower level; total length, 415 feet; perpendicular depth of lower level, 282 feet.

At the upper level gangways are driven E. and W., and a tunnel cut Northward. This tunnel, which is about 150 yards in length, intersects three coal-seams dipping Southward. The last of these, known as the "Joe Wright Vein," saddles over into N. dip, and is cut at the end of the tunnel just at the level of the synclinal next N.*

The *Lyon Coal,* divided into two benches by 8 inches of bony or impure coal, is 6 feet thick at an average. The Pasco is 6 feet thick, and the Wright has 3 feet of good coal. The latter turns flat on the axis 30 yards above the tunnel, and dips Northward 45°. It is mined only 70 yards up the long breast N. of the basin.

From the tunnel-level the E. gangway on the Luther Slope Coal is 900 yards long; the W. gangway, 774 yards. The Lyon bed is worked 450 yards W. of the tunnel, and 75 yards E. The Pasco, 250 yards W., and 60 yards E. The Wright coal on its first S. dip 35 yards E., and 75 yards W. This W. gangway deflects Northward upon West-dipping coal, indicating a gradual falling away of the saddle in that direction. On the S. dip of the basin the same bed is mined 400 yards W., and 40 yards E.

The lower slope-level is mined W. 774 yards, and E. 2000 yards.

The slope is now being extended to begin another level 100 yards lower. Its total length will then be 515 feet.

All the beds mined at this colliery yield Red-Ash Coal.

The yield of the Casca William collieries in 1856, from the Black Valley water-level drift and the Luther Slope, was 45,177 tons. In 1857, the product from the Raven Slope for 9 months—the Luther Slope, 12 months—and a small gin-slope mining surface-coal, 6 months—also the West Delaware Mine on W. Norwegian—was 39,399 tons.

None of these mines are shipping coal.—(March 1, 1858.)

Novelty Colliery, near New Philadelphia (page 125 of text) — Lessee, George Rickert, (formerly, Connor and Rhoads).—A slope-mine upon the Spohn Coal-bed dips Southward 35°; length, 750 feet; three levels below water-line; the two lower levels are 300 feet apart. The upper and middle slope gangways are now abandoned. They were mined 900 yards W., and 500 E. The lower level now worked is 400 yards E., and 300 W. The upper levels E were abandoned because of a fault in the coal, bearing South-eastward.

The Spohn seam averages 4 feet 6 inches of coal. It is overlaid by 9 feet of slate, which forms the bottom

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* An error will be detected in the Casca William Section, illustrating the structure and number of coal-seams at this point. The progress of mining subsequent to the construction of that Section, has shown that the beds noted at the outcrop as the Lyon, Pasco, and Joe Wright seams, are the same which have been cut in the tunnel successively beneath the slope coal. The lowest of these, after forming a basin at the tunnel-level, rises gently Northward, and at or near the surface, rolls over an axis, and into a basin, both between the Axes D and E of our Section, from which it emerges to crop out where we have placed it. These last flexures are not shown in our Section, and will account for the seeming great distance of the Wright below the Pasco bed.

of a smaller bed 3 feet thick. This has been reached by short tunnels cut from the Spohn gangways, and is mined parallel with the latter.

The yield, in 1857, was 30,667 tons.

Bare Ridge Colliery (page 127 of text)—Lessee, John G. Hewes, formerly Oliver.—Situated on the S. side of Bare Ridge opposite Cwmbola. Slope on the tunnel vein S. dip 30° at top, increasing to 41° at bottom; length, 865 feet to lower level; below water-line, 585 feet; three levels—the first 225 feet below water-level; the two lower 180 feet apart. The first lift is worked out and abandoned. The lower level is mined 450 yards E. and 400 yards W.; the middle level, 300 yards E. and W. A dirt-fault, 100 feet wide, crosses the E. gangways obliquely, bearing South-eastward.

The coal mined at this colliery burns to deep red ash. The bed between slates is 5 feet thick; though of good coal, between 3 and 4 feet only is mined. There are three benches in the seam, the upper and middle usually separated by 5 or 6 inches of bony coal.

The yield, in 1856, was 20,186; in 1857, 22,194.*

Silver Creek (page 120 of text).—There is an important error in the section upon Silver Creek which we wish here to correct. By referring to the passage, the reader will perceive an interval of 500 feet is represented as existing near its Northern end between what is indicated as Dodson's Orchard, and the small coal-seam next below the Slope coal called the N. Diamond. This interval should be eliminated by shifting the Southern part of the section Northward, so that the Slope coal occupies the position of the Orchard, and the bed next below it the position of the Primrose. Making this correction, it will at once appear that a modification of the nomenclature is necessary, and we are compelled to regard the Primrose Coal as the proper equivalent of what we have called the North Diamond. Any corrections or deductions based upon this error in our section will at once suggest themselves. Thus the total number of the coal-beds must be reduced by two, and a change must be made in the synonyms of the Silver Creek Coal-beds.

Madison Colliery—G. J. Jones (formerly Beatty & Co.)—The great Chadwick White-Ash Coal-bed (mined in 1853 by Guiterman & Co.) is that upon which the operations of this colliery are based. On Silver Creek no change of dip is observable between the Chadwick bed and the Tucker Slope coal. If, notwithstanding this fact, the seams be regarded as identical, we must infer that there is at this point a sudden and sharp inversion of the strata, or a fault along which the Tucker bed has been upheaved without leaving any trace of North-dipping strata.

At the Madison Colliery two drifts enter the Chadwick bed at different levels on the breast. The subdivisions of the seam are as follows:—

		Feet.	In.			Feet.	In.
"South Vein."	Coal, . . .	12	0	"North Vein."	Coal, . . .	5	0
	Bony Coal, . .	1	6		Slate, . . .	0	3
	Coal, . . .	4	6		Coal, . . .	0	2
					Slate, . . .	0	6
	Slate, . . .	5	0		Coal, . . .	5–6	0

This is the average character of the bed. Within the mine, about 700 yards E. of the entrance on the upper level, the 5 feet bed of slate disappears by thinning away, or is lost in the confusion of the bed which is crushed and broken, owing to a circumstance to which we will presently advert. This confusion of the bed extends 300 yards E. from where it is first encountered; after which the lower division seems permanently enlarged, and the whole bed is sound.

The two drifts follow the bottom slate of the lower division E., and short cross tunnels through the dividing-slate give access to the upper member or S. vein. The dip at the mine mouth is 40°; this gradually declines to 25°, and rises to 60° in the E. extension of the workings. In the upper level the breasts, ascending both the upper and lower seams, cut through coal, dipping nearly vertically N., and then pass into conglomerate in the former case, and slate in the latter. These breasts became successively shorter, and at 600 yards in the one case, E. of the

* Agard and Tyler's Slope at Cwmbola, also that of the same operators at Belmont, Colahan's Shaft, near Cwmbola, and the old Salem Slope at Young's Landing, near Pottsville, are all worked out and abandoned.

drift mouth, and at 650 yards in the other, the rock came down to the gangway level. The facts thus stated lead at once to the inference that the small anticlinal roll (D), indicated in our section as affecting the second coal-seam below the Chadwick Double Bed, declines towards the E., and causes the great bed to fold over and around it into nearly vertical N. dips. It is for this reason that the breasts became successively shorter, and encountered the wall of slate and sandstone. The sharpness of the turn causes the confusion in the bed at the point of the saddle on the gangway level, while the slowness with which the crest of the arch droops away E. gives rise to the great expansion of the coal at that point. The somewhat exaggerated thickness assigned to the bed in the text (page 120) is due to this abnormal mass of coal.

A cross-cut from the axis of the saddle cut N. 60 yards, crossed a basin of the coal which rises W. and into regular S. dips ranging E. The rise W. of this basin is proved by the gangway W. from the N. end of the tunnel; in this the coal became soft and crushed, and opposing dips were found. The gangway, E. from the N. end of the tunnel, met the main gangway prolonged from its S. end.

The only effect of this declining saddle and rising basin in the lower gangway is to cause some variation in the slope of the breasts, until, as the gangway advances E., the breasts from it are worked out to the outcrop without interference. The upper coal in this lower level is nipped out by the approach of the top rock to the bottom slates, 1100 yards E. of the mine mouth. The gangway on the lower division is 1450 yards long.

From the lower level the coal was followed down the dip at an angle of 25° to a distance of 38 yards, when the top rock came vertically down, and the seam was entirely cut off. This may be due to a fault with an upthrow which has elevated the coal far above water-level at the Tucker Slope Colliery, in accordance with the views of those who regard the seams as identical, or, what is more probable, as a simple crushing-out, with perhaps a trivial dislocation of the bed.

The Madison Colliery, in 1856, shipped 38,431 tons of coal; in 1857, 22,061 tons.

Guiterman's Colliery (page 120 of text)—Lessee, H. Guiterman & Co.—The next seam below the Chadwick Bed mined at this colliery is also a white ash coal, subdivided as follows:—

Coal, from 5 to 6 feet; Slate, 1 foot; Coal, impure, 3 feet.

The anticlinal and synclinal flexures alluded to in describing the Madison Colliery, have affected this bed in a precisely similar manner. The water-level gangway, driven E., encounters faulty or crushed coal 500 yards from the mine-mouth, and about the same distance W. of the similar disturbance in the Chadwick Bed. The gangway was prolonged, through this and across the adjoining crushed basin, into sound coal on a regular S. dip of 45°.

The middle level was abandoned when it reached the point of the saddle. The upper level is a drift working out coal from the S. dips of the basin. Aggregate length of gangways, 2400 yards.

This colliery yielded, in 1856, 20,700 tons; in 1857, 15,636 tons.

Silver Creek Colliery (page 121 of text)—Lessee, John Tucker.—This is a Slope mine, descending S. on the bottom slate of the "North Vein," at an angle declining from 60° near the top to 40° at the bottom. Length of slope, 447 feet; below water-level, 297 feet.

The thickness of the bed is very variable; it is estimated to yield 10 feet of coal, subdivided as follows:—

Coal, 4 feet 6 inches; Slate, from 4 to 12 inches; Coal (blacksmith's), from 20 to 24 inches; Bony coal, from 6 to 9 inches; Coal, 5 feet.

From the foot of the slope a tunnel is cut S. 25 feet through slate to the "South Vein." This seam is 30 feet thick, but crushed at the tunnel in the E. gangway. Its normal subdivisions are,—

Bony Coal, 3 feet; Slate, 9 inches; Coal, 1 foot 6 inches; Slate, 2 inches; Coal, 2 feet; Slate, 2 inches; Coal, 1 foot 6 inches; Dirt and slate, 1 foot 3 inches.

The slate division between these two beds—the "North and South Veins"—increases at the water-level going E., from 6 inches to 30 feet. In the slope gangways a similar gradual enlargement occurs, amounting to 50 feet of strata, requiring a tunnel 126 feet long between the two seams, at a point 500 yards E. of the slope.

The slope gangway E. on the lower coal is 1500 yards long, on the upper beds 1000 yards. The presence

of a synclinal trough rising W. causes a slight deflection in the gangway on the upper coal W. of the tunnel above alluded to. This basin is probably the W. prolongation of that encountered in the Old Raven Slope on Casca William.

The W. gangway from the tunnel is now abandoned, the coal having proved faulty.

The yield, in 1856, was 69,554 tons; in 1857, 34,641 tons.

Neill's Slopes on the N. Diamond (Primrose) and S. Diamond (Orchard) seams, were both abandoned early in 1858. The first is about 200 feet long, the latter 591, dipping 35° to 45° S. A tunnel driven N. from the gangway of the Orchard Seam cut the Primrose Bed in 210 feet, and the Holmes in 375 feet. The anticlinal (E.) ranges 205 feet N. of the latter.

Diamond Colliery—J. M. Lewis & Co. (formerly Winterstein); in 1853, Chadwick & Co.—A slope is sunk on the Gin Seam at an angle of 55° S. on the S. side of anticlinal axis G., and W. side of Silver Creek. Length, 120 yards to lower level. Upper level, 60 yards from the surface. The upper gangway is driven 100 yards E. and 1000 yards W. From the gangway, 40 yards W. of the slope, a tunnel is cut 30 yards Northward to the Diamond Seam, upon which a gangway is driven 1000 yards W.

The lower gangways are recently started. The Slope coal averages 10 feet 6 inches in thickness; the Diamond, from 4 feet 6 inches to 6 feet. Both seams were somewhat crushed and dirty in the breasts.

In 1857, 7591 tons were mined and sent to market.

ZACHARIAH'S RUN.

Oakdale Colliery (page 128 of text)—Valley Furnace Lands, Windy Harbour—Lessees, Whitfield & Dornan.—Slope Mine sunk on the N. dip of the Diamond Coal at an angle of 65°. Length, 105 yards; below water-level, 83 yards. The Diamond Vein is subdivided by a slate band, 3 inches thick, into an upper bench 3 or 4 feet, and a lower 2 feet thick. Upon it gangways are working E. and W. In the E. gangway, 50 yards from the Slope, the coal is compressed to 18 inches thickness, for a distance of 15 yards, by the approach of the top and bottom slates.

From the foot of the Slope a tunnel is driven N. 33 yards to the Primrose Seam. The thickness of this bed has not been yet proved, nor have any gangways entered it.

The yield in 1857, from two months' mining, was 1356 tons.

Windy Harbour Colliery—Bowman & Co. (formerly S. Sillyman).—This slope, situated at the head of the valley of Zachariah's Run, is sunk 100 yards on the Skidmore Seam at an average dip of 60°. From the foot of the slope a tunnel is cut Southward 117 feet to the Mammoth Bed, also dipping steeply S. This seam at the tunnel is 20 feet thick, in two main divisions, separated by 2 feet of slate. This slate grows thicker going E.; and within 100 feet from the tunnel it gives place to a stratum of sandstone, which completely divides the coal into a lower seam 10 feet thick, and an upper 12 or 15 feet. The gangways following the two divisions of the coal diverge gradually, and 1400 feet E. of the point of separation are 95 feet apart. At this point the S. gangway deflects Southward for 100 feet on faulty coal, dipping gently Westward, and then turns E. The N. gangway pursues a normal direction until influenced by a W. dip which deflects the gangway Southward. The coal at this point is shelly and impure. The Slope coal is 10 feet thick, including several slate divisions. The average amount of coal is 7 or 8 feet. It is mined 800 feet E. from the Slope.

The yield of the Colliery, in 1857, was 13,870 tons.

E. RAVENSDALE.

Lawrence Grove Colliery (page 130 of text)—R. M. and L. Lewis's Tract, in the valley of E. Ravensdale—Lessee, William Price.—This is a drift-mine working E. upon the Primrose Bed, or Fitzimmon's Coal of Zachariah's Run, dipping 36° S. from the fifth anticlinal S. of Mine Hill. Its thickness is variable, between 8 and 14 feet; average, 10 feet; it is in two benches, separated by a dirt-parting. Length of gangway 800 yards, and about 250 yards from an old gangway driven W. from Zachariah's Run; breast on coal 50 or 60 yards. A tunnel is cut 61 yards Northward from the gangway, 50 yards E. of the entrance to the Holmes or Henderson Coal, which is

5 feet thick, in two benches. This has not yet been mined to any extent. Immediately N. of the outcrop of the Holmes Seam, an anticlinal (H) passes, which causes that bed to turn over into steep N. dips. The Primrose Bed has been mined towards the W. from Zachariah's Run on the nearly vertical N. dip of this saddle, by J. J. Williams, who obtained from it, in 1857, 4524 tons. A slope will probably be sunk at Price's Colliery at an early day.

In 1856, Mr Price mined 6967 tons; in 1857, 22,649 tons.

In the valley of Zachariah's Run, Mr John G. Hewes of Pottsville, in the year 1856, conducted a boring, which was made from the water-level on the fifth anticlinal S. of Mine Hill (H), beneath the arch of the Brooke Seam, now regarded as the equivalent to the "Seven-foot Vein" overlying the Mammoth. This boring, 93 feet deep, cut a large coal. A slope was subsequently sunk 100 yards on the Brooke Seam, dipping N. 80°, and a tunnel driven S. 74 feet to the Mammoth. Where cut by the tunnel, this bed was only 4 feet thick, but it widens out in the breasts to 25 feet. A colliery will be established at this point.

CROW HOLLOW.

Rainbow Colliery (page 131 of text)—Kirk & Baum (formerly S. Sillyman).—These mines are exclusively above water-level. The present gangways are entered by a tunnel driven Northward from the valley of Crow Hollow, about half a mile E. of Snyder's Mount Hope Slope. This tunnel is 400 feet long to the 7-feet coal, and is prolonged with a slight change of direction to the Mammoth Bed. Upon both of these beds gangways are driven Eastward a great distance. The coals possess their average dimensions, and dip 10° S. at the tunnel. In the W. gangway the 7-feet bed is faulty and impure. The workings upon the Big Coal have warped around a declining anticlinal, that likewise affects gangways of the Mount Hope Mine, and into the rising basin next N. of it. It is to be observed regarding these curvatures of the gangway, that the effect of the rapidly-rising basin is to cause W. dips, while the saddle will fail to present decided N. dips, merely causing, in miners' language, a "throw" of the vein to the Southward. The flexures are traceable as more important rolls of the strata farther Eastward.

A few hundred feet N.E. of this point a tunnel is cut Northward 85 yards from the outcrop of the Big Coal to what is known as the Skidmore Seam. In the gangway the coal is pinched down to 18 inches, and the mining in that direction was abandoned. Eastward the coal is thin for 10 yards; it then enlarges, and the gangway is driven upwards of 1½ miles. The thickness of the bed varies from 6½ to 8 feet, and it is underlaid by 3 feet of dirt and slate.

The yield of this colliery, in 1856, was 65,871 tons; in 1857, these mines, and the Carey Slope to be described, yielded together 90,888 tons.

Crow Hollow.—Sawmill Tract (page 131 of text)—M. C. Diehl's Drift follows the Holmes Bed 600 yards Eastward. The average thickness of coal is 5 feet 6 inches in two benches, sometimes separated by 2 inches of bone coal. Dip 32° S. at the drift-level, declining to 20° in the breasts. Length of breasts, 60 yards. The yield, in 1856, was 8629 tons; in 1857, 6621.

Near the outcrop of the Primrose Bed, 60 yards S. of Diehl's Drift, a boring was made in 1853 upon the lands of the North America Company. The notes of this boring are already presented on p. 134.

MILL CREEK.

Eagle Colliery (page 132 of text)—Lessee, William H. Jones.—The great White-ash Coal-seam, lying near the base of the Coal-measures on Mill Creek, is wrought at this colliery by slope and water-level drift. The drift enters upon a bed commonly called the "Seven-foot," which is separated from the great bed by from 6 to 9 feet of slate. The following section represents these beds:—

Coal streaked with slate, more or less impure, 6 to 7 feet; Slate, 6 to 9 feet; Coal, 5 feet; Coal, 7 feet; Slate, sometimes absent, 2 feet 5 inches; Coal, 2 feet; Coal, 7 feet; Slate, 5 inches; Coal, sometimes dirt and slate, 2 feet.

From the gangway on the "Seven-foot Bed," the underlying big coal is entered by tunnels cut through the dividing-slate. The dip at the drift entrance is 25° S.; this gradually increases E. until the coal stands vertically,

but it gradually declines again while the direction of the dip changes, and the gangway, following the bed, warps round the basin of the coal at a distance of 4800 feet E. After making this turn the gangway ranges W., nearly parallel to its former course upon the opposite or S. side of the basin. At this level the basin is 300 feet wide. The presence of an anticlinal (probably the true axis D of Silver Creek and Casca William, if we regard axis D of the Mill Creek Section as local), lying S. of the basin and sinking W., causes the gangway to sweep S. and E., while the coal dips at a low angle to every point of the compass, from N. to W. and into the regular S. dip of the anticlinal. The latter curvature is 2200 feet W. of the former. Passing this, the gangway observes its normal direction towards the E. Along the line of the basin and saddle rising gangways follow the coal E. towards the outcrop.

The slope descends S. on the bottom slate of the Great Bed 573 feet to the lower level; to the upper level, 311 feet. The angle of dip declines from 27° at the top to 11° at the bottom. In sinking this slope a serious disturbance in the strata was encountered, which for a time impeded profitable mining. About 150 yards from the top of the slope, the great bed, which had hitherto held its normal thickness, was found compressed by the approach of the overlying and underlying strata. This thinning of the bed continued until at length the seam had entirely disappeared, or its horizon was indicated only by a thin streak of black dirt. The lower portion of the slope, therefore, is cut through rock. From the foot of the slope the leader was followed about 50 yards E., when the top and bottom diverged, and the bed resumed its normal dimensions. The course of this "nip" is S. of E. A similar trouble occurred in Chillis's old water-level gangways upon the same seam on the W. side of Mill Creek, and caused the abandonment of those mines. The lower-level gangway from the slope is mined E. about 1800 feet. At that distance it encountered a wall of rock running obliquely across the gangway in a direction N. 20° E., the face of which dips towards the gangway at an angle of 30°. Approaching this the coal becomes confused and contorted. The coal rises along the face of this rock 20 feet, though diminished in thickness, and on top of it lies nearly horizontal. Followed E. from the fault which we have indicated, the bed is completely nipped out in 200 yards by the approach of the top and bottom slates.

The anticlinal roll which we have noticed as causing a curvature of the water-level gangway on the big coal, descends so rapidly W. as to leave no indication of its presence at the slope; but about 1500 feet E. of the slope it causes the upper-level gangway to branch—one part following the very gentle N. dip of the saddle, the other its W. and S. dips. The latter gangway has recently encountered the same rock-fault previously noticed as causing a stoppage of the lower level. At this point the rock dips 60° N. to 80° W. at the gangway level. As in the former case the coal is confused, and rises along the plane of the rock, but under what thickness, and how far, has not yet been determined. An attempt is being made to follow the coal in the hope that the upheaval has not injured its quality on the level of the upthrown portion.

It is to be observed that the bearing of this fault intersects the range of the strata at an angle of about 50°. Its line must therefore cross the saddle; but it seems to have caused no disturbance in the drift-level, before reaching which its effects must have expired. We have not sufficient data to guide us to a full understanding of the nature and extent of this curious disturbance in the strata.

The yield of this colliery, in 1856, is reported at 83,712 tons; in 1857, 88,040 tons.

The seam underlying the Johns Bed, locally known as the Skidmore, was wrought in 1857 by J. Schlotman & Co., from a drift above water-level. It is 4½ or 5 feet thick, and yielded 5099 tons. A bed occupying the same relative position to the Big coal on the N. side of Mine Hill dipping N., was wrought by W. J. Uhler, and produced 5260 tons.

Pine Forest Slope (page 132 of text)—Lessee, George W. Snyder (formerly, Snyder & Milnes).—This colliery is situated upon the Great Mammoth Bed, and its overlying contiguous coal-bed, known as the Seven-feet coal. The former of these presents the following average subdivisions:—

Slate and coal mixed, 2 to 3 feet; Good coal, 4 feet 6 inches; Parting, sometimes thin slate; Hard good coal, 7 feet; Parting; Hard coal, 5 feet; Slate and dirt, 1 foot; Hard coal, 7 feet; Slate, 6 inches; Coal, sometimes soft, 2 feet 3 inches.

This will represent the condition of the bed under favourable circumstances at the several Mill Creek

Collieries, where it is mined. The Mammoth Bed is overlaid by a stratum of slate, from 7 to 9 feet in thickness, upon which reposes the "Seven-foot Vein." The several parts are as follows :—

Good coal, including a thin variable slate, 2 feet; Parting; Good coal, 5 feet; Slaty and bony coal, 8 feet 10 inches; Rough coal, 1 foot 6 to 2 feet.

The Pine Forest Slope descends S. at an angle of 17° upon the bottom slate of the Mammoth Coal Bed for 650 feet, and deflects 30° E. to keep within the line of the property; length between levels, 380 feet—total, 1030 feet. The sump gangway, to be used as a water reservoir, encountered the basin of the coal 150 feet from the foot of the slope. This basin, ranging E. in the bearing, N. 72° E., and rising in that direction, causes the upper level gangway E. to curve S. round the end of it; S. of the basin the presence of a partially-developed anticlinal roll in the coal drooping W. causes a reverse curve in the gangway, which there observes its normal direction. The deflections occur half a mile W. of the slope. From the upper gangway the top slate is cut through one-third of a mile E. of the slope, and a gangway is driven on the Seven-feet coal-bed.

The lower level gangway is influenced by the same basin which affects the upper level in a similar manner; it will eventually sweep round to the E. parallel with the upper workings. The upper level is 5000 feet long, and is now abandoned. No gangways have been driven W. from the slope.

The *Mount Hope Slope Mine* is situated one-third of a mile E. of the preceding, and conducted by the same person. It follows the bottom slate of the same great seam at an angle of 23° S. 13° E. to the basin of the coal; length to the basin, 720 feet. In prolongation of the direction of the slope, an inclined plane on the opposite dip rises at an angle of about 15° for 200 feet, and is continued as a slowly rising gangway until, passing the crest of the saddle previously noticed as affecting the upper gangway of the Pine Forest Slope, it curves W. and ranges along the flank of the arch. At different levels on the rising gangway, roads are run off to the E. From the foot of the slope, and from a higher level on the rising plane, gangways diverge S.W., which curve concentrically around the saddle, returning into the main avenue. In several parts of the mine short tunnels are cut into the Seven-feet coal, upon which gangways are driven.

A gangway cut E. from the foot of the slope rose towards the surface with the W. dip of the coal, but at 800 feet distance was impeded by a rock-fault. Air-courses are run up the breasts of the coal at convenient points, by which the mine is ventilated. The total length of the gangways in this mine is about 3¼ miles.

St Clair Colliery—Lessees, William Milnes & Co. (formerly Pinkerton).—This slope mine descends upon the Mammoth Coal-bed on the W. side of the valley of Mill Creek in range with the Pine Forest Slopes. Its length slightly exceeds 1200 feet, inclined S. at an angle of 23° at the top, but becoming nearly flat at the bottom. There are three levels of gangway in the mine—the first 500 feet from the top, the second 250 feet lower; none of these are mined to the E. The upper-level gangway, W., has worked out nearly all the coal above it as far W. as the property line. The two lower levels have not advanced far. The lowest gangway ranging W., deflects S., owing to the nearly flat dips of the basin of the coal. The water-level drifts upon the overlying Primrose Coal-bed were similarly affected. The thickness of the Big coal and the Seven-feet is normal at the slope, though the latter is faulty; but followed W., the Big coal dwindles to 15 feet, while the Seven-feet increases to a thickness of 15 feet, the quality of the coal not deteriorating.

The yield of this colliery, in 1856, was 123,128 tons; in 1857 it fell off to 81,135 tons.

Carey's Slope Mine—(Lessees, Kirk & Baum).—This slope is 650 feet W. of the Pine Forest Slope, and descends upon the same Great Mammoth Bed upon the adjoining tract; length, 834 feet, inclining Southward 24° at the top, declining to 14° below. The gangway W. from the slope is 1000 feet long. Eastward, two gangways are laid out, one following the bottom slate of the bed, the other keeping immediately beneath the top slate; from the latter an air-way descends along the dip of the coal at an average angle of 15° to the E. gangway workings from Carey's Shaft. In one part of this air-way a local upward bulge in the roof-slate causes an increased thickness of the bed. The two Eastern gangways above alluded to converge in working horizontal coal, from which point the main gangway turns Southward on the W. dip of the bed, and finally sweeps to the

Eastward upon its regular S. dip. From the top of the slope a short tunnel is cut to the overlying 7-feet coal, upon which gangways and breasts are mined out in the usual manner.

Carey's Shaft Colliery (page 133 of text)—Lessees, Kirk & Baum.—A perpendicular shaft is sunk, cutting the Primrose, Holmes, and several trivial beds, and the 7-feet and Mammoth seams to the bottom slate, of which the depth is stated to be 435 feet. The last two beds only are mined. They present the usual subdivisions and thicknesses proper to them in the district, as we have previously stated them. The average of good coal is 16 feet in the large bed, and 7 feet in the smaller seam. The gangways observe a normal direction from the shaft Eastward 1000 feet, and Westward 700 feet. In the latter direction the dip of the coal does not exceed 10° S. Two tunnels are driven to the 7-feet bed, upon which gangways are laid out.

Primrose Slope (page 134 of text)—Lessee, F. J. Parvin.—The slope follows the bottom slate of the Primrose Pink-Ash Coal-seam 100 yards to the first level at an angle of 20°, and 65 yards at a dip of 15° to the second level, at which the coal turns flat for 20 yards, and then dips Southward at an angle of 8°. The coal-bed averages 14 feet in thickness in two benches, without dividing-slate; parts of the lower bench are occasionally somewhat bony. The upper level is worked 140 yards E., and 600 yards W. The lower level follows the horizontal coal 120 yards E.; the coal becomes soft in that direction. This flattening of the seam is due to the rise of two small basins, which, as they sink Westward, cause the gangways to diverge in that direction. The Southern gangway occupies the centre of the Southern Basin; it is 200 yards long. The breasts on the bottom slate of the coal rose from this 15 yards S., and 5 yards N., at both of which points the strata roll over into contrary dips. The Northern basin was followed by a slope, but the influx of water caused its abandonment. The Northern gangway on the main slope breast of the coal is at present 300 yards long. The breasts from it extend to the upper gangway level, an average distance of 50 yards.

This slope raised, in 1856, 25,330 tons.

In 1857, this colliery, and a Red-Ash slope-mine to be described, leased by the same party, yielded, with five months' working, 19,846 tons.

Lewis Red-Ash Colliery (page 135 of text)—Lessee, F. J. Parvin.—A slope-mine on the bottom slate of the Peacock Coal-bed 100 yards below water-level. Coal, 6 feet thick; dip 45° S., increasing to 50°. This seam has been worked out. From the gangway, 200 yards W. of the slope, a tunnel is cut Southward 40 yards, through rock and slate, to the Clinton Coal, 3 feet thick. Dip 50°; upon which a gangway W. is 600 yards long. The tunnel, prolonged 62 yards through rock-slate and two small coal-seams, intersects the Big Tracy, and is to be extended to the Little Tracy, which it is expected to strike near the basin. The Big Tracy, where it was cut by the tunnel, is 20 feet thick, but shelly and impure. Its uniform normal thickness varies between 6 and 8 feet, including 2 feet of bony coal; the latter is not always present. Dip, 50° S.; gangway, W., 200 yards long.

Production, in 1856, 17,296 tons.

Lewis Red-Ash Colliery, E. side of Mill Creek (page 135 of text)—George W. Snyder's (formerly, Snyder & Milnes).—The slope is sunk upon the Lewis Coal-bed, dipping S. at an angle of 30° to 32°. Length, below water-level, 84 yards; to water-level, 33 yards; gangway E., 1800 yards. 170 yards E. of the slope a tunnel is driven N. 165 yards, by estimation of the mine captain, through slate and rock to the Yard coal, which has been worked E. to the line. The tunnel is prolonged 50 yards Northward to the Spohn Bed, which was found in fault; a second tunnel is therefore cut to this, 400 yards E. of the former; the coal still proves faulty, though a limited amount of good fuel has been taken from it.

The Lewis Seam is 4 feet 6 inches thick, and is not subdivided by any persistent slate-bands. The Yard coal is nearly 3 feet thick. Both these beds are subject to irregularities arising from the approach of the top and bottom slates on the one hand, or from mere degeneracy into black crumbly dirt on the other. The frequent recurrence of these conditions in this, as in many other mines, has sadly interfered with the profits of the colliers.

A new lift of 90 yards is about to be sunk upon the Lewis Bed.

EAST NORWEGIAN.

Flowery Field Slope, N.W. of Wadesville (page 146 of text)—Wasley & Co.—This slope is sunk at an angle of 37° obliquely upon the bottom slate of the "7-feet Vein," the true dip of which is 44° S. It is 684 feet long. The Slope coal at this mine presents the unusual thickness of 12 or 14 feet. It has been worked 1100 feet E. from the slope. The slate, 12 feet thick, dividing this bed from the Mammoth Seam, has been cut through by a short tunnel 150 feet E. of the slope; and a gangway is driven E. 500 feet upon the latter. The Mammoth Seam is 25 feet thick. The colliery is not now worked. In 1857, Treck & Spencer shipped coal from it during a part of the year.

Flowery Field Tunnel—Lessee, Mr James (formerly George Mason).—This tunnel is driven Southward 310 feet to the Flowery Field or Orchard Coal-bed, dipping gently S. The bed is from 5 to 5 feet 6 inches thick. Over the top slate, which is 4 feet thick, a 3-feet bed of coal is wrought from this tunnel. From the gangway, 200 feet W. of the tunnel, a cross-cut extends 200 feet Southward through nearly flat coal and rock occupying the central parts of the basin to the N. dip of the same beds. The gangways Westward from the two ends of this cross-cut converge and unite in 350 feet. Gangways are cut in various directions through the coal occupying the basin, until about 750 feet W. of the convergence of the gangways they are affected by the deepening of a basin, the axis of which is nearly in line with this basin, rising Westward; this causes a divergence of the gangways. The Southern branch deflects Southward upon the W. end of the drooping anticlinal that passes between the old slopes on the North and South-dipping Primrose Coal.

An upper-level drift on the breast of the Flowery Field bed, 600 feet N. of the tunnel gangway, is worked half a mile Westward. There is some confusion in the bedding of the coal in this drift, and some evidence of a shallow narrow basin producing a divergence of the gangways. The main N. gangway only on the regular S. dip is now mined.

These mines yielded, in 1856, 16,581 tons; in 1857, 18,943 tons.

A fourth of a mile E. of Mason's Tunnel, on East Norwegian, C. Frantz & Co. are mining the Orchard and Primrose seams above water-level on the Ellmaker Tract. The Orchard Bed dips Southward 10° or 12° at the drift-entrance; but on the breasts, 55 yards above the gangway, 200 yards in, the coal saddles over into a shallow basin on the N. The gangway, which is driven Westward, is 250 yards long. The Orchard Seam in this mine is 4½ or 5 feet thick, including 2 or 3 inches of slate, 2 feet from the bottom. The lower bench of coal is rough in texture.

The Primrose Bed, 7 feet thick, divided by 7 inches of slate, and 5 inches of bony coal, is wrought from a drift in which the coal dips 8° or 10° Southward. The gangway is mined 100 yards Westward.

C. Frantz & Co. mined, in 1857, 4123 tons of coal.

A colliery has been recently established in a shallow basin of the Orchard Coal-seam occupying a high position in the hill W. of Wadesville. From the gangway both dips of the coal are mined. Lessee, James Thomas.

In 1857, the Primrose Seam South of the basin was wrought by Mr Thomas, and yielded 15,841 tons of coal.

WEST NORWEGIAN.

East Mount Laffee Slope (page 147 of text)—Turner & Gowan (formerly C. Miller).—This is sunk on the bottom slate of the Mammoth Bed; length, 195 yards; to first level, 135 yards; to water-level, 75 yards. Dip, 50° at top; 61° at bottom. The coal above water-level was wrought from the old Mount Laffee Tunnel. The upper-slope level is wrought 1200 yards E.; the lower, 600 yards E. Both gangways W. encountered rock-fault, or a gradual thinning-away of the coal, until it entirely disappeared 260 yards from the slope. The "7-feet Vein" overlying the Mammoth is wrought from gangways, communicating by short tunnels with the Mammoth gangways.

The subdivisions of the beds wrought from this slope are thus stated by Mr Gowan :—

	Feet.
Coal,	4
Bone Coal,	1
Coal,	6
Coal,	2

	Feet.	In.
Slate,	1	3
Sandstone,	2	6
Slate,	2	0

	Feet.	In.
Coal,	9	0
Bone Coal,	1	6
Coal,	6	6
Bone Coal and Slate,	2	0
Coal,	6	0

The first slope-level at the slope was on fire in 1857, and no coal was taken from the mine.

T. T. Jenkins & Co.'s Colliery (page 147 of text)—formerly Pugh & Co.—This mine is situated upon the S. dip of the first anticlinal traversing this part of the region S. of the Mine Hill (Axis E). A slope is sunk 100 yards upon the Primrose Bed of coal, at an angle of 15°, or 60 yards below water-level. A drift follows the same bed E. at water-level. Owing to the fact that the anticlinal at which this bed arches over droops towards the E., this gangway turns N., then W., upon the N. side of the axis. This curvature of the gangway occurs 1400 feet E. of the slope. The North-dipping coal was wrought years ago from a slope-mine, the breasts of which have been entered by the drift gangway. From the present slope the gangway has been worked E. half a mile, and has not yet experienced the effects of the declining saddle.

The average thickness of the Primrose Bed in this mine is 6 feet.

Yield, in 1856, 13,838 tons ; in 1857, 19,958 tons.

C. A. Harper's Slope, on the *Lower Orchard Coal-Bed,* is situated 250 feet W. of Brown's Old Shaft : length, 419 feet ; to first level, 314 feet. Dip at the top, 22°, decreasing to 7° at the bottom, where it approaches the basin of the bed. The level gangway E. on the first lift is turned S. by the rising of the basin : a rising gangway is worked obliquely across the basin to nearly vertical coal on the S. side of the synclinal.

The Orchard Seam retains the thickness and character usual to it through this part of the region.

Yield, in 1856, 13,419 tons ; in 1857, 15,481 tons.

A company is proposing to sink a vertical shaft somewhere near Mr Brown's house in the basin.

D. P. Brown's Oak-Hill Slopes, on the Primrose Seam, are situated upon the S. side of the second anticlinal S. of Mine Hill (Axis F West). The old slope descends, at an angle of 28°, for 300 feet, being 263 feet below water-level. At the bottom the E. gangway is 450 yards long. The W. gangway, 400 yards from the slope, sweeps N. round the saddle, which declines W. into nearly vertical North-dipping coal.

From the foot of the slope a tunnel is cut 232 feet S. to the Lower Orchard Coal, dipping 35° S. Upon this bed a gangway is driven 300 yards W. and 750 yards E.

The new slope is sunk on the Primrose Coal 35 feet W. of the old one ; its length is 630 feet ; dip of coal at the bottom, 45° S. At this level the E. gangway is 200 yards long ; the W., 100 yards.

The usual subdivisions of the Primrose Bed, at the mines on West Norwegian, may be represented as follows :—

Coal, from 3 to 4 feet, Pink Ash ; Bony Coal, 1 to 3 inches, White Ash ; Coal, from 1 to 6 inches, Red Ash.

The Lower Orchard Seam is 5 feet thick, divided into two main benches, without parting-slates.

The West Oak-Hill Slope (Lessees, D. P. Brown & Co.) is sunk on the Primrose Bed from the outcrop on the first anticlinal S. of Mine Hill, between the valley of West Norwegian and the West Branch : length, 300 feet to the gangway level ; dip, S. 30° at the top, 12° at the bottom. Gangways are opened 100 yards E. and W. from the slope. On the W. side the dip becomes so gentle that cars are run up the breasts. The bed at this mine is reported to contain 8 feet of fuel.

Yield of the Oak-Hill Collieries in 1857, 30,860 tons.

West Delaware Mine (Rogers & Luther).—A slope is sunk on the Diamond Coal-bed, dipping S. into the fourth main synclinal basin S. of Mine Hill : length to lower level, 300 feet ; to upper level, 180 feet. Upon each level, gangways are driven E. and W. The upper level, W. 400 yards, ran into a rock-fault. A leader of the coal was followed 200 yards without passing through the fault. This fault or nip of the coal bears S.W. ; the lower level, 300 yards W., has not yet reached it. From the upper-level gangway, 400 yards E. of the slope, a tunnel is cut S. 70 feet to the vertical N. dip of the basin of the coal. This cross-cut passed through coal, and

the bottom-slate of the bed, which is upheaved upon a sharp narrow anticlinal flexure, which divides the general basin into two compressed basins. A rising gangway driven E. from the S. end of the cross-cut, passed over the saddle into the N. small basin, meeting the gangway prolonged E. upon the regular S. dip, 300 feet E. of the cross-cut. In the N. basin the coal is bent sharply back upon itself, and seems to end downwards as a wedge-like mass: as this wedge expanded with the rise of the basin E., a large mass of coal was laid open to mining. W. from the cross-cut a gangway is opened 750 feet on the vertical coal. At the point where this gangway ends, the basin between the gangways is 233 feet wide. The outcrops at the slope are about 130 yards asunder.

The Diamond Seam is stated to average 9 feet in thickness in the parts of the mine now wrought. A band of slate, from 6 to 18 inches thick, not always present, divides the bed into two benches. Ash, deep red.

Yield in 1856, 43,072 tons.

The Old Peach Mountain Delaware Mines are abandoned.

Duncan Colliery (Lessee, J. F. Voorhies).—This slope, in sinking, follows a leader of the Lewis Coal-seam, which is from 3 to 7 inches thick. The inclination of the slope is 36° S. for 104 yards from the surface. It then passes 41 yards through a large body of sound coal, the full development of which has not yet been ascertained, to the normal bedding of the seam dipping 28°, which is followed 175 yards to the gangway-level. Total length, 320 yards, or 960 feet. The gangway E. from the slope communicates with the gangway driven W. from the slope on the Lewis bed, sunk at the bottom of the Old Shaft on the Centre Tract. This shaft is 255 feet deep to the Lewis Coal, upon which the slope is 510 feet long. The position of the Duncan Slope was established by an air-way driven to the surface from the gangway 800 yards W. of the Lewis Slope. Previous to this demonstration of the position of the bed on the Duncan Tract, every attempt to find it had failed. It would appear that the great expansion of the bed to which we have referred, is due to a sudden compression arising from the forced approach of the over and underlying slates as they near the outcrop. The line of this compression or fault rises Westward, as has been proved by an air-way W. of the slope, in which it was encountered at a higher level. The W. gangway from the slope is opened 700 yards; but no coal has been mined from it for the market.

The Lewis Seam is divided into three benches: beneath the top bench 4 inches of slate usually accompany the bed. The estimated average thickness of coal is stated to be 6 feet 6 inches. Ash, deep red, fracture semi-conchoidal.

The Lewis Shaft Colliery, worked by Mr Voorhies as agent, yielded, in 1857, 8554 tons. In 1858 it was not worked.

The Old Black-Mine Slope (wrought for many years by Mr G. H. Potts), on the York Farm, near Pottsville, was abandoned in 1857. It is nearly a fourth of a mile long, and has five levels of gangway communicating with it.

WEST BRANCH.

West Mount Laffee Slope (Turner & Gowan).—Situated on the S.E. side of West Branch Gap of Mine Hill. Sunk on the Mammoth Seam 62 yards below water-level; dip 50° at the top, 35° at the bottom. The average thicknesses of the Mammoth and Seven-feet Coals somewhat exceed that of the same beds wrought in the East Mount Laffee Slope. In the gangway the upper bed is confused and very variable, owing to irregularities in the top and bottom slates, which sometimes recede from one another, enclosing an immense body of coal. Above the gangway-level these irregularities become less frequent, and the coal is more uniform and sound. W. of the slope 50 yards this bed is entirely cut out by the approach of the top and bottom slates. The W. gangway on the Mammoth Coal is driven 78 yards; the dip grows less in that direction, causing a slight deflection in the gangway. The E. gangway on the Mammoth is wrought 800 yards to a dirt-fault, accompanied by a great diminution in thickness. The interval of 600 yards between the face of this gangway and the W. gangways from the East Slope, though suspected to be faulty ground, yet remains to be tested.

East of the slope 200 yards a tunnel is driven 46 yards S., from the top of the "Seven-feet Coal" through confused measures, which have hitherto been little understood. Careful examination of this tunnel led to the conviction, that for the first 17 yards it is cut through a shallow basin of the strata immediately overlying the Seven-feet Seam. That bed, rising to the tunnel-level, forms three narrow confused anticlinal rolls, and finally descends below the tunnel-level on a S. dip of 30°. The N. dip of the last and most important of these rolls is

nearly vertical. A short distance W. of the tunnel an attempt was made to cut an air-way to the surface on the breast of the S. dip of this saddle; but 20 yards on the breast the coal turned over into a N. dip, and the attempt failed. The drooping of this saddle Eastward caused the abandonment of the gangway in that direction. The flexures we have described do not appear to be developed as important rolls in the strata to any great distance, though we may find in them an explanation of the fact, that the strike of the Mammoth at the West Mount Laffee Slope-coal ranges some distance N. of the same bed wrought by Doherty at the Dundas Colliery, No. 1, on the W. side of the valley.

It is probable that, in the prolongation of the West Mount Laffee Slope to a lower level on the Mammoth Seam, a flattening of the dip, or a synclinal in prolongation of the basin of the tunnel, will be encountered, and affect the breast in the coals.

This colliery, wrought four months in 1857, yielded 9382 tons of coal.

Dundas Colliery, No. 1 (page 168 of text)—Lessee, John Doherty (formerly C. M. Hill).—On S. slope of Mine Hill, at West-Branch Gap, W. side, the slope descends on the bottom slate of the Mammoth North Coal-seam, at an angle of 25° S. Length of slope, 773 feet; to first level below water-line, 485 feet. The upper level from the slope, and an old water-level gangway, encountered a rock-fault or nip of the seam 3100 feet W., and were abandoned. The lower-slope level is driven 1200 feet W.

Dundas Colliery, No. 2 (erroneously called No. 1 on page 168)—John Doherty (formerly Jones).—Situated 1000 feet W. of No. 1. Slope 849 feet long on the South-dipping Black Valley Seam; to first level, 545 feet: dip, 33° at the top, 22° at the bottom. The upper-slope level is mined 2100 feet E., and 3300 feet W. The lower level, 750 feet E., 850 feet W.

The following section represents the subdivisions of the coal-seams wrought at the two collieries:—

		Feet.	In.
Black Valley	Coal,	0	10
	Bony Coal,	0	6
	Coal,	9	0
	Slate, two thin coals, from 10 to	12	0
Black Heath	Coal,	2	6
	Slate and bone,	3	0

		Feet.	In.
Mammoth	Coal,	2	6
	Slate and bone,	2	6
	Coal,	1	6
	Slate,	...	4
	Coal,	4	0

The Black Heath and Mammoth seams range Eastward as one great bed, designated the Mammoth; whereas the Black Valley is known as the Seven-feet Coal. Towards the W., however, they appear as three entirely distinct seams, separated by many feet of conglomerate and sandstone. Thus, at the No. 1 Slope the Black Valley and Black Heath seams are separated by 15 feet of slate; but from that point Westward intercalated sandstone and conglomerate appear, which, at the water-level on Wolf Creek, actually exceed 125 feet in thickness, requiring nearly 200 feet of tunnel across the dip to pass from the one to the other. Even at the No. 2 slope, across which our section is measured, the seams are thrown asunder. In like manner the Black Heath is separated from the Mammoth in the same distance by 40 feet of conglomerate, requiring 63 feet of tunnel between the two. These facts make the hypothesis of the identity of the Black Heath and Seven-feet bed (see page 223) altogether improbable.

Dundas Colliery, No. 3 (Lessee, Morgan Brace).—This is a drift-mine at water-level working Westward on the (so-called) Reese Davis or Bast White-Ash Seam. The coal at the mine-mouth dips S. 35°; but 300 yards Westward in the gangway it basins, and rises a short distance, after which the gangway follows the S. dip. The average thickness of the seam is stated at 6 feet. The mine is now abandoned, temporarily at least. In 1857, 2789 tons were extracted from it.

Dundas Colliery, No. 4 (Lessees, Treck & Spencer).—The Kear Vein or Oak-Hill Seam is wrought at this colliery by a slope 480 feet long; an upper-level gangway leaves the slope 180 feet below the water-line. The coal at the slope dips S. 22° at the top, and 15° at the bottom. The upper level is mined 800 yards W.; the lower, 175 yards W. and 180 yards E. The lower gangway, 100 yards W. of the slope, encountered a dirt-fault 8 yards wide on the breast, but ranging nearly parallel with the gangway for 40 yards. In the upper level the same fault was struck 450 yards from the slope. It is there 15 yards wide through 70 yards of gangway length.

In the E. lower level, 140 yards from the slope, a large oval mass of sandstone occurs, lying within the coal, which, beneath the rock, is compressed to 2 feet of thickness. The coal has been cut away from its sides; but whether it is isolated from the natural top-slate of the bed by coaly matter is not proved. The coal in the vicinity of this curious feature is confused, soft, and sulphury. The subdivisions of the bed in this mine are thus stated:—

Coal, 4 or 5 feet; Coal, 1 foot 6 inches; Slate, 6 inches; Coal (14 inches bony), 3 feet; Coal, sometimes dirt, 1 foot 6 inches.

The character of the bed, and the extension of mining Eastward from West Branch, seem now to favour the view commonly entertained, that the Kear of Wolf Creek and Primrose of West Norwegian are identical beds.

Dundas Colliery, No. 5 (Holman & Co.)—A slope is sunk on the Diamond Seam 360 feet: dip at the top, 43°; midway, 25°; at the bottom, 45°. From the foot of the slope a tunnel is driven 25 yards S. to a seam of coal 2 feet 6 inches thick, upon which gangways are being opened. The Diamond Seam is 4½ or 5 feet thick in two benches, separated by 4 inches of slate. Gangways are worked 500 yards E. and W. From the gangway, 200 feet W. of the slope, a tunnel is driven 367 feet N. to a coal from 3 to 4 feet thick. This seam arches over a saddle beneath the surface, to form a shallow basin rising Westward. An air-way 80 yards W. of the tunnel proved the existence of the saddle.

This colliery yielded, in 1857, 17,429 tons.

Peach Orchard Colliery (page 169 of text)—Bullock & Spencer.—A slope is sunk on the E. side of the Valley of West Branch, immediately E. of the Old Wagner Tunnel, upon the Peach Mountain Seam, or the second coal-cut in that tunnel: length of slope 120 yards; dip, 30° S. From the foot of the slope a tunnel is driven N. and S. The first seam was cut 28 yards N. of the Slope Coal; it is 3 feet thick, and corresponds to No. 1 of the Wagner Tunnel. From this the tunnel is prolonged 45 yards N. to a seam of rough coal from 5 to 7 feet thick, dipping 30° S. Upon it a gangway is driven 200 yards E. In the opposite direction from the slope, the tunnel is driven S. to the Peach Mountain Seam, dipping 50° N., and is prolonged to the seams cut in the N. tunnel. Though the tunnel is driven 70 yards S. of the lowermost of these, no other seams are found, though the dip is still N.

Occupying the synclinal (o O) of the Peach Mountain, but basining 42 yards above the tunnel-level, there is a seam of coal, generally confused, though sometimes yielding 8 feet of coal. A slope 100 yards long descends upon this bed to the basin, on both sides of which breasts are wrought in the coal. The rise of the basin E. throws out the upper seam, and after it the Peach Mountain. In its E. extension this latter bed was wrought many years ago by John Reed for the Delaware Coal Company. Following W. from West Norwegian the S. dip of the coal on the anticlinal next S. of the basin, he tunneled through into the basin, and extracted the coal.

The Peach Mountain Seam is denuded away from the flat ground of the West Branch, but descends in a steep N. dip on the opposite side of the valley. A small colliery was established on the bed at this point, from which Mr Bright, in 1857, shipped 4423 tons.

The Peach Orchard Colliery is temporarily abandoned.

MINERSVILLE.

Lewis Colliery (page 169 of text)—Lessee, William De Haven.—Situated at the W. end of Minersville. The slope descends on the Phœnix Bed, dipping 40° S. from the anticlinal of the Old Minersville Tunnel; length, 123 yards. From the slope a tunnel is driven S. 70 yards to coal from 3 to 4 feet thick, and is prolonged 100 yards to the Peach Mountain Seam, dipping 45° S. Gangways are driven from E. to W. upon all these beds. The Phœnix Bed, though about 5 feet thick, is slaty and impure; it is not now wrought. The Peach Mountain Seam is thus subdivided:—

Coal, 3 feet; Coal, 2 feet to 2 feet 6 inches; Slate or dirt, 2 inches; Coal, 2 feet.

A third of a mile W. of the Minersville Slope the Peach Mountain Coal is mined from a slope 90 yards long, It dips 40° S. The gangway is driven 400 or 500 yards W. from this slope. A gentle roll of the coal 200

yards W. displaces it in the gangway ; a short tunnel is driven to the bed, which dips so feebly S. as to admit the cars on the breast. The coal is shelly in the neighbourhood of the disturbance in the mine.

WOLF CREEK.

William Penn Colliery (page 169 of text)—Agent, J. C. Harper.—The Kear or Oak-Hill Seam on the E. side of the valley of Wolf Creek forms a shallow basin rising E., from which the coal has been extracted by Holman & Co. South of this basin it arches the anticlinal F West, beneath a stratum of coarse conglomeritic sandstone. Harper's Slope cuts 20 yards through this rock to the coal, which is struck near the saddle, and is followed on the S. dip : length of slope, 480 feet ; dip, 40° at top, 45° at bottom. There are two levels 213 feet apart on the slope. The E. gangways have been mined nearly 600 yards. The upper level W. is 100 yards long ; the lower, 400 yards.

The seam is estimated to contain 10 feet thickness of coal at this colliery ; it sometimes exceeds this.

The yield, in 1857, was 12,545 tons.

Schollenberger Colliery (page 171 of text)—Lessee, B. Bartholomew, jun.—Situated on the S. side of Mine Hill, Wolf Creek. The slope descends S. on the bottom slate of the Black Valley Coal, 340 feet to the first level, and 286 feet farther to the lower level. The inclination is 34° at the top, increasing to 44° at the first level, and 37° at the bottom. At the foot of the slope the coal is found greatly confused and worthless. A tunnel cut S. through this "trouble" 155 feet to the next higher coal, displays an obscure faulty synclinal and anticlinal structure in the Slope Coal and its associated rocks. The Bast White-Ash Coal, or Reese Davis Seam, laid open to mining by this tunnel, is subdivided as follows :—

Coal, 1 foot ; Bone Coal, 6 inches ; Coal, 3 feet 6 inches ; Coal, rough, 4 feet.

The E. gangway 900 feet from the tunnel curves S. upon West-dipping coal. After rounding the point of the basin, it returns to its former course upon the N. dip. to meet the gangway driven W., which encountered the uprising of the same basin in that direction 300 feet from the tunnel. At this point the coal is somewhat confused. The coal at the E. end of this basin dips 23° W. ; the N. dip varies from 19° to 23°. An anticlinal axis (F West) ranges within 100 feet S. of the gangway on the S. side of the basin. Near the foot of the slope a tunnel is cut N. from the Black Valley Bed 156 feet to the Black Heath Seam, dipping S. parallel to the former. Midway in the tunnel a small seam of soft coal was passed. The several members of the Black Heath are,—

Coal, rough, 1 foot 6 inches ; Coal, 10 inches ; Coal, 4 feet ; Coal and Slate, 1 foot.

Gangways are worked more than a fourth of a mile E. and W. of the tunnel.

The Black Valley Seam proved so unprofitable that the upper-level gangways upon it were abandoned.

Schollenberger's (Old) Slope—(formerly Heilner's).—This slope is 400 feet S.E. of the former. It is 100 yards long below water-level on the Bast White-Ash Coal seam at an angle of 30° S. At the foot of the slope a tunnel cut S. 130 feet intersects two small seams of poor coal. From the gangway 300 feet W. of the slope a tunnel is driven N. 350 feet to the Black Heath Coal, cutting the Black Valley Bed midway. The Black Heath Bed has been mined a mile W. by gangway from the tunnel. W. of the tunnel 3200 feet the strata below it are cut through by a tunnel 60 feet long to the "Back Vein" coal-bed, which is thus subdivided,—

Slate and Coal ; Rough Coal, 6 inches ; Slate, 4 inches ; Coal, 2 feet 10 inches ; Coal, 2 feet 5 inches ; Coal and Slate, 2 feet to 2 feet 8 inches.

A gangway is driven several hundred yards W. of the tunnel upon this bed.

The Schollenberger Collieries, in 1857, produced 40,513 tons of coal.

Sutton and Wright's Tunnel—(Lessees, Cain, Hacker, & Cook).—This tunnel is cut at water-level through South-dipping strata 260 feet N. to a seam of coal overlying the Black Heath Seam, called the "Red Ash." This is followed by gangways 1560 feet W., and a tunnel is cut 60 feet to the Black Heath Bed. The Back Vein, also tunneled to, is worked W. to the line. Following this Black Heath coal 1030 feet W., a tunnel is driven from the gangway S. across the measures through a confusion of dips 280 feet to a small coal, which was traced 200 feet

S.W., and the tunnel resumes its direction 80 feet to the Susan, and 110 feet farther to the overlying Petherick coal-seams. The Susan Bed is 7½ feet thick, as follows :—

Rough Coal, 8 inches; Slate, 4 inches; Rough Coal, 2 feet; Slate, 3 inches; Coal, 1 foot 3 inches; Coal, 3 feet.

It has been mined 300 yards W. from the tunnel. The Petherick is thus subdivided :—

Coal, 2 feet 2 inches; Coal, 4 feet 7 inches; Slate and Coal, 1 foot.

It dips 41° S. at the tunnel, but followed E. the gangway deflects S. round a small basin, and into a N. dip. of 14°, following which W. it will perhaps meet within 100 yards the air-way from the Bast White-Ash Slope Colliery previously described. Driven W. from the tunnel, the gangway workings connect with the E. workings on the same seam, known as the Forestville Bed, mined from West-West Branch.

It is an opinion commonly entertained that the Petherick and Susan beds cut in Bast's Tunnel, and wrought at a higher level at the S. end of Sutton and Wright's Tunnel, are the same as the Black Heath and Back coal-seams wrought far below water-level in Schollenberger's gangways, and at water-level at the N. end of Sutton and Wright's Tunnel; also, at a still higher level, from Serrill's Upper Tunnel. In explanation of this hypothesis, a sudden and sharp anticlinal inversion of the strata is supposed to occur, causing the Petherick and underlying bed to descend so far below water-level as to rise on the natural S. dip in Schollenberger's gangway. We know of no facts to justify this view of the case. The anticlinal (F West) which droops E., affecting Bast's E. gangway on the Reese Davis Bed, as described, in its prolongation W. ranges through the confused ground of Sutton and Wright's Inner Tunnel. We also know that the basin next N. of this rises rapidly W.—so rapidly that it expires without affecting the Schollenberger gangway on the Black Heath Seam. Inasmuch as the identity of the Reese Davis Coal at Schollenberger's and Bast's White Ash is proved by mining, the more natural view of the Petherick and Susan seams is to regard them as represented at Schollenberger's by the Black Valley, and a soft seam of dirt and coal, which in that mine is not worth working.

Yield of this colliery, in 1857, 19,843 tons.

Borda's Black Heath Colliery, head of Wolf Creek (page 171 of text)—Forest Imperial Company's Lands.—The tunnel by which the seams wrought at this mine are entered, known as Serrill's Upper Tunnel, is situated 175 yards E. of Sutton and Wright's Inner Tunnel, and 160 feet above it. As shown in the engraved section, it is driven N. into Mine Hill, cutting three notable seams of coal. The first of these, or the Black Valley Bed, is so confused at the tunnel that it was not mined there, but was tunneled to from a gangway driven 400 feet W. on the first bed. From this tunnel the Black Valley Seam was wrought W. nearly 400 yards. The breasts on the Petherick Seam, wrought from the W. gangway of Sutton and Wright's Inner Tunnel, communicate with this old gangway, thereby establishing the identity of the bed under two names.

The mining from the main tunnel on the Black Heath and Back seams has been very extensive. The breast on the Black Heath Coal from the tunnel W. admits a counter-level above the main gangway for 1150 yards, from which point the subsidence of the dip and the rise of the surface W. allow of two counter-gangways. The coal in the main lower gangway is finally cut out by rock-fault, which caused a stoppage of the gangway 1800 yards W. of the entering tunnel. The dip of the coal in the neighbourhood of this fault furnishes some indication of a basin rising W., accompanied by a small anticlinal roll on the S. The gangway working W. from a slope, sunk 70 yards on the coal below this main-tunnel gangway, encountered a change of dip and a rock-fault or "nip" of the coal, 2000 feet E. of the rock-fault above mentioned.

No difficulty, similar to that in the lower levels, has been met with in the counter-gangways. The slope level worked E. connects with the gangway on the Black Heath Bed, driven W. of Sutton and Wright's Inner Tunnel.

At several points tunnels have been driven N. to the Back Vein, which is worked from the entering tunnel parallel to the Black Heath, and in a similar manner. The total length of the gangways upon the Black Heath and Back seams which have an outlet at the Serrill Upper Tunnel exceeds 6 miles.

This colliery shipped in 1857, as the result of four months' mining, 30,754 tons. Estimated capacity for 1858, 80,000 tons.

Bast's White-Ash Colliery (page 171 of text)—Lessee, George H. Potts.—The Old Slope descends S. 195

feet upon the bottom-slate of a small seam, overlying the Bast White-Ash or Reese Davis Coal-bed; it then cuts through the underlying strata to the latter bed. Length, 402 feet.

The dip decreases uniformly from 46° to 18°.

The thickness of the coal averages from 7 to 8 feet, as follows:—

Coal, 1 foot; Soft Coal, 3 inches; Coal, 3 feet 6 inches; Coal, 6 inches; Coal, 3 feet 3 inches; Coal and Slate, 0.

An anticlinal flexure (F West), drooping E., shortens the breasts, and causes the gangway to deflect N. a fourth of a mile E. of the slope. The synclinal basin which, by rising W., turns the gangway, in confused coal on the lower level from Schollenberger's Slope Tunnel, affects this gangway similarly, causing a reverse curve. From this gangway, 300 feet E. of the slope, a tunnel is driven S. 175 feet to a seam which is mined a short distance E. and W.

From the gangway, 530 feet W. of the slope, a tunnel is cut S. 105 feet to the seam upon which the upper portion of the slope descends. This bed is 6 feet thick, and is mined 1600 feet W. In the opposite direction a tunnel is driven 386 feet to the Susan Vein, cutting the Petherick Bed 66 feet S. of the latter. The Petherick only is extensively mined by gangways from this tunnel. It has been followed 3400 feet W. and 1000 feet E. In an air-way ascending the breast of the coal at 1440 feet W. of the tunnel, the dip changes, 332 feet above the gangway, to N. 37°, and in 34 feet, to a basin of which the S. dip averages 6° for 105 feet, when another turn occurs, over which the coal was not followed; but the bed reappears on a S. dip in the gangway from Cain, Hacker, & Cook's Tunnel. The narrow basin thus formed rises E., and the gangway from the tunnel has already passed round it, and is expected to communicate with the air-way. The two small anticlinal rolls we have indicated droop E., causing confusion in the coal, and a shortening of the breasts in the Black Heath Coal-bed 1000 feet E. of the air-way.

The New Slope is sunk upon the same Bast White-Ash Seam 650 feet W. of the former. It is 498 feet long to the Old Slope gangway, and 853 to the bottom. Inclination 49° at the top, 27° midway, and 33° at the bottom.

The gangways running E. are 1200 feet long, and those W. 700 feet. From the foot of the slope a tunnel is cut 70 feet S. to the upper coal-bed, upon which gangways are opened for mining.

Bast's Red-Ash Colliery (Lessee, George H. Potts).—The slope is sunk on the Diamond Coal-seam dipping S. 40°; length, 664 feet. The upper level is worked out and abandoned. The E. lower gangway, 2000 feet long, nearly approaches Holman's Workings, coming W. from West Branch. The W. gangway is 3800 feet long. From the W. gangway, 275 feet from the foot of the slope, a tunnel is driven 400 feet S. to the Cockle Bed, 5 feet thick, dipping 40° S. Upon this coal gangways are worked 400 feet E. and W. Midway in the tunnel a 3-feet bed of impure coal was cut, and followed 400 feet W.

The Diamond Seam comprises three benches of coal, the lower and middle separated by 4 inches of slate. The entire thickness of the bed ranges from 6 to 7 feet.

The yield of the Bast Collieries, in 1857, was 106,773 tons.

Kear's Colliery (page 172 of text).—Slope descends 187 yards on the Kear or Oak-Hill Seam: dip 30°, increasing to 38°; length to upper level, 87 yards. The upper level is worked 200 yards E., and both levels 1600 yards W. In the upper level, 1430 yards W. of the slope, a small synclinal and anticlinal roll of the coal causes a sigmoid curve in the gangway, throwing it 125 feet S. of its previous line. The lower level is affected in precisely the same way by these flexures, 1050 yards from the slope. Intermediately, a counter-gangway is similarly curved.

The Kear Bed is stated to average 10 feet thickness, including from 8 to 9 feet of coal.

WEST-WEST BRANCH.

Forestville Colliery (D. Glover), Forest Improvement Company's Lands, S.E. Side of Mine-Hill Gap of the West-West Branch.—Slope sunk 137 yards on the bottom-slate of the Forestville or Black Valley Seam; dip 22° S. at top, 30° at bottom. From the foot of the slope, gangways are driven 1200 yards E. and 1400 yards W.

The dip of the coal diminishes going E., and increases W. to 50°. In the W. gangway the coal is faulty and impure for two-thirds of the distance mined.

Above water-level the coal has been wrought from three levels of gangway.

The subdivisions of the coal are as follows :—

Davis Coal, 4 feet 6 inches ; Slate and Bone, 4 feet ; Coal, 2 feet ; Bone Coal, 3 inches ; Coal, 3 feet ; Slate, 6 inches ; Coal, 3 feet 6 inches.

The above section represents the bed under favourable conditions. In parts of the mine the Davis Bed only is important ; in others it is not wrought, and the main coal depreciates in thickness and quality.

Yield, in 1857, 56,995 tons. Capacity for 1858, estimated at 50,000 tons.

Franklin Colliery, S.W. Side of Mine-Hill Gap of the West-West Branch (William De Haven).—Slope sunk 100 yards on the Kear Seam ; dip, S. 34° at top, 55° at bottom. Gangway driven E. 1300 yards, the dip augmenting to 70°, gangway W. 1100 yards. Average length of breasts on W. side, 95 yards to water-level ; on E. side, owing to steep dip, 40 yards. The prevailing subdivisions of the bed are as follows :—

Coal, 3 feet 6 inches ; Coal, sometimes 1 foot of it bony, 2 feet 6 inches ; Coal, 2 feet 6 inches to 3 feet—Ash, pinkish grey.

Shipments in 1857, including coal sent from the Lewis Colliery, near Minersville, 53,701 tons.

Dolbin and Rogers' Colliery (at Woodside).—Slope sunk on bottom-slate of the Reese Davis or Bast White-Ash Coal-seam, dipping S. 28° at top and 35° at bottom ; length, 108 yards. At the bottom of the slope the coal was squeezed out by a rock-fault. After driving 200 yards E. through rock, the coal reappeared as a workable bed, and is mined for 700 yards E. of the slope. From the slope a tunnel is driven S. 32 yards to a small seam, upon which a gangway is opened W. for 257 yards, where a tunnel is cut back to the slope-coal, here only 3 feet thick. A gangway follows it W. a short distance.

At water-level a tunnel is driven towards the slope 420 feet to the Reese Davis Coal, which was worked out years ago. W. of the tunnel 1700 feet, a second tunnel is cut N. 90 yards to the Black Valley or Forestville Coal-seam. Midway in the tunnel a small seam was passed. The gangway on the Forestville Seam is worked nearly a mile E. The average thickness of the coal is about 6 feet.

The yield of this colliery, in 1857, was 35,333 tons.

Big Diamond Slope (Charles Miller's).—The Big Diamond Seam which, owing the influence of the drooping anticlinal (M), arches below water-level on the E. side of the valley of West-West Branch, rises with the anticlinal W., and on the W. side of the valley a slope is sunk upon it to a depth of 140 yards below water-level. The dip at the top is 34° N., but it declines to a small basin, and rises on the opposite dip of a small anticlinal roll which was overcome by a cross-cut of 15 yards. From the foot of the slope a gangway is driven along the basin 200 yards W. At this point the basin seems to be flattening out ; a cross-cut is made Northward 24 yards to the regular N. dip of the coal, upon which the gangway is driven 1200 yards W. In the opposite direction from the cross-cut the gangway is driven towards the slope, and 30 yards E. of it. The E. gangway from the foot of the slope is abandoned, because the coal is squeezed and thin. The Diamond Seam is stated to yield on an average a thickness of 6 feet 6 inches of coal.

Phœnix Colliery, E. Side West-West Branch (page 174 of text)—C. Miller.—Slope sunk 100 yards below water-level on the Phœnix Seam, or Cockle's Red-Ash (erroneously designated in our section as the equivalent of the Oak-Hill Seam), flanking the S. side of the second anticlinal S. of the Diamond Slope, or axis N. The dip is S. 24°.

From the bottom of the slope a gangway runs 800 yards W. At the end of this gangway a change of dip occurs, from a S. dip of 20° into a N. dip of 60°, becoming vertical in the breasts. The coal is confused.

From the slope Eastward a gangway is driven 1000 yards ; a tunnel is then cut Northward through the anticlinal of the coal, from 35° S. to a 45° N. dip of the bed. This anticlinal droops gradually Eastward. From the N. end of tunnel the gangway is driven W. 370 yards to the rising basin of the coal, which swings the gangway N. to the regular gentle S. dip of the coal on the flank of the anticlinal next N. This anticlinal (M), which causes the arch of the Big Diamond Coal to droop below water-level in ranging from the

W. to the E. side of West-West Branch, as it subsides Eastward will in like manner affect the Phœnix Seam. The gangway driven 400 yards E. of the turn at the basin is already deflecting Northward as the coal changes from S. to E. dips.

The old water-level gangway was affected in a smilar manner.

The average thickness of the Phœnix Seam is 4 feet 6 inches of coal. On the first S. dip the coal is shelly, but in the basin it is sound.

The Old S. Phœnix Slope is sunk 50 yards on a seam from 3 to 4 feet thick, but so impure that but little coal was taken from it, and the mine has been abandoned.

Shipments in 1857, including Big Diamond Colliery, 38,889 tons.

Beury's Colliery (formerly Macdonald's), two-thirds of a mile E. of the Phœnix Colliery.—The Kantnor or Peach Mountain Coal-seam, dipping S., is entered at water-level by a drift which follows it Eastward 450 yards. At this point the gangway turns Northward, while the coal, warping round the drooping anticlinal (N) of the Phœnix Mine, is completely crushed out. From the gangway near the drift-mouth a tunnel is cut N. 107 feet to a smaller underlying coal, thought to be the seam of the S. Phœnix Slope. This bed is faulty and impure at the tunnel. The measures separating it from the Peach Mountain Coal are represented as having so far thinned away at the end of the main gangway that a short oblique tunnel penetrates to it. The coal at this tunnel is 5 feet thick, and sound. The bed is mined 150 yards on the N. side of the anticlinal. Shipments in 1857, 3644 tons.

Thomas Cassiday's Colliery.—On the W. side of the West-West Branch, a little below the Phœnix Colliery, a drift enters upon a seam of coal 3 feet 6 inches or 4 feet in thickness; dip 23° S. The gangway is driven 500 yards W. Owing to the gentle dip of the bed, and the height of the upland above the water-level, the breasts are 100 yards long. The Peach Mountain Coal is opened on the same dip, a short distance S. of the drift, but it is not mined. Shipments in 1857, 8356 tons.

At Cressonville, between the West Branch and the West-West Branch, the Salem Coal has long been wrought by a slope on a S. dip. The length of this slope is about 500 feet to the lower level. Above this there are two others not now worked. The upper level E. was driven to a fault; the second level E. is 150 yards long, coal unsound; it is driven half a mile W. The lower level is driven 200 yards E. and 500 W. Shipments in 1857, 2608 tons.

N. of this slope the Rabbit Hole and Faust seams have been wrought above water-level, and the tunnel and Black Mine by slopes below. These works are now abandoned.

Fogarty's Slope Colliery, on the Black-Mine Coal near the W. Branch, is now abandoned.

In the *Sharp Mountain,* at the gap of the *West Branch,* a seam of coal, the third ascending in the series, is wrought to some extent by John Doherty. The seam dips S. 80°. Two gangways at different levels are driven Eastward from the gap: the upper is 300 yards long; the lower, 400 yards. The thickness of the coal in the lower level is 13 feet; in the upper the average is about 10 feet. It is divided by a slate band 4 or 5 inches thick. The upper member is variable; the lower is solid, and in the lower gangway of increased thickness. It is confidently asserted by some persons that the quality and appearance of this coal are so nearly like the Mammoth of Mine Hill as to establish their identity. The test is not a sound one. It seems to be the Barcleugh Seam of our section, given on Mr Bennett's authority.

Salem Colliery (page 175 of text)—B. Tyson & Co.—In the valley of the West Branch below Llewellyn.—A slope is sunk on the tunnel-seam 127 yards; dip S. 40° at top, 45° at bottom. The gangway driven W. is 600 yards long. Ninety yards W. of the slope a tunnel is driven N. 88 yards to the Black-Mine Seam. A bed 15 inches thick was cut 33 yards N. of the slope coal. The Black Mine dips 38° at the tunnel, though flatter on the breast. The gangway is driven 150 yards E., and 500 yards W.

A new slope is now sinking upon the Black Mine at an angle of 30° at the top and 40° below. It intersects the gangway 15 yards E. of the tunnel. It will be 250 yards long from the outcrop, or 100 yards below the tunnel-level.

The tunnel-seam averages 5 feet thickness in this mine: it is not divided by slates, though somewhat tending to dirt-faults. The subdivisions of the Black-Mine Seam are thus stated:—

Coal, 1 foot 6 inches; hard dark argillaceous Sandstone, 10 inches; Coal, 2 feet; Dirt undermining, 2 inches; Coal, 2 feet 6 inches.

The rock-parting is sometimes wanting, and occasionally is replaced by slate.

Yield of this colliery, in 1856, 22,276 tons; in 1857, 23,988 tons.

The Old Salem Slope-Mine on West-West Branch is abandoned.

Miller's Colliery (S.E. of the Old York Tunnel, Costerville).—The Kear or Otto Grey-Ash Coal-seam, which is cut 40 yards S. of the N. end of the Old York Tunnel, dips Southward below water-level, and, after forming a basin, is elevated below the surface on the crest of a saddle (**M**). The slope at this colliery is so located as to strike the seam on the saddle, and descend with it on the S. dip. The slope was sunk 60 yards at an angle of 35° through North-dipping measures to the coal, which was followed 30 yards on an average dip of 40°, when it was nipped out, but came in again near the bottom of the slope. Total length, 130 yards. From the slope, gangways are opened 90 yards W. and 75 yards E. The Kear Bed at this mine is divided into two benches of coal, each 5 feet thick, separated by Bone coal from 5 inches to 2 feet in thickness. No coal shipped in 1857.

MUDDY BRANCH.

Morgan and Edwards' Tunnel Colliery (page 176 of text)—D. Edwards, Forest Improvement Company's Lands.—This tunnel (a section of which, so far as it had been driven in 1853, is presented on page 157 of the text) is driven N. into Mine Hill above water-level at the head of the valley of Muddy Branch. It intersects a number of seams of coal at the following distances from the mouth:—

160 feet of loose earth to the Brittain Seam, 10 feet thick; 261 feet to the Anderson Seam, 9 feet coal and slate; 563 feet to the Forestville or Black Valley Seam, 10 feet thick; 592 feet, passing a small seam, to the Billy Best Vein, 7 feet thick; 680 feet, passing two small seams, to a 3-feet bed of slaty coal at the end.

The dip is nearly uniform 65° S. The only seams wrought from this tunnel are the Forestville and Best. The gangway on the Forestville Seam is driven E. 330 yards, and 1040 yards W. On the Best Vein the gangway is worked 140 yards W. and 120 yards E. The extension N. of the tunnel from the Black Valley Seam was made in 1856–57. Yield in 1857, 10,477 tons, mining only a portion of the year.

Forest Improvement Company's Otto Mines (R. Heckscher & Co.)—At this colliery three seams are wrought—the Grey-Ash, sometimes called Brittain's, and represented to the E. by the Kear or Primrose Seam; the White-Ash or Forestville Black Valley Seam; and a small seam underlying the latter, and known as the Little Vein. The first is now wrought exclusively below water-level, the two last above water-level only.

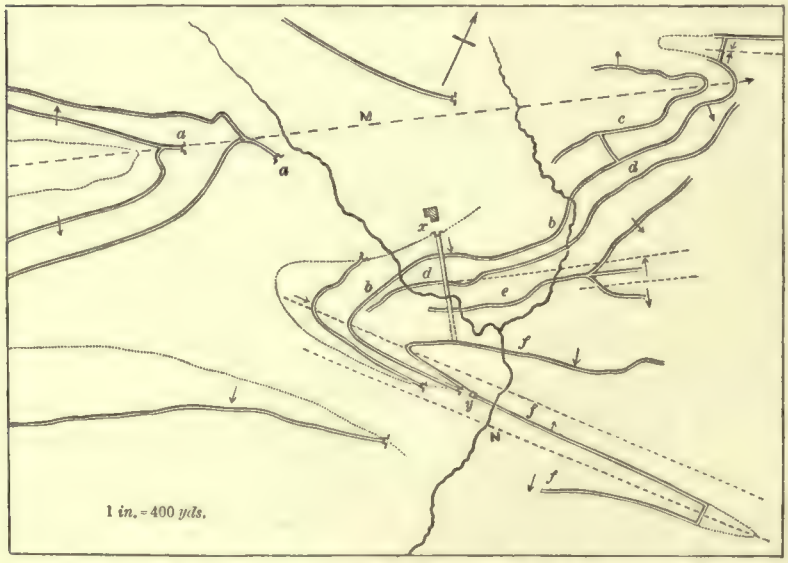


FIG. 312.—Ground Plan of the Otto White and Grey Ash Collieries.

The structural features developed by the mining upon these seams are among the most curious and instructive anywhere exhibited in the region. We shall attempt to describe these, so far as they are at present understood, by aid of the annexed diagram.

The broad anticlinal (**M**), the axis of which ranges immediately S. of the Falls of the Swatara, is flanked on both sides by the Otto White-Ash Coal and its underlier, the "Little Vein." On the W. side of the Swatara the two outcrops of the same seam are not less than 900 yards apart; but the anticlinal droops E., causing the outcrops to converge and unite 2000 yards E. of the stream. At this point the coals dip E., and are entered at and above water-level (the upper, or White-Ash Seam, is near the anticlinal axis) by two short tunnels, from

which gangways diverge more and more, going W. as they approach the Swatara. On the S. dip the gangways are driven a mile W., and on the N. 1600 yards. The average N. dip is 50°, the S. 25°. At convenient points, tunnels, the lengths of which vary with the angle of dip, are driven to the Little Vein, which is mined on both dips of the anticlinal. The actual thickness of rock cut through by these tunnels is about 40 feet. Gangways are driven on the Little Vein parallel to the main gangways, and the small seam is wrought in the same manner, though not to the same extent. The main coal averages a thickness of 10 feet when sound. The S. gangways are abandoned because the coal is entirely cut out by rock. The lower coal, 6 feet thick when regular, is liable to degenerate to slate.

The Otto Grey-Ash Seam is estimated to lie 100 yards higher in the series than the White-Ash Bed. The gangways upon it, both above and below the water-level, have, in keeping their level, been influenced by three well-marked anticlinal rolls, including as many synclinal basins.

The anticlinal of the Swatara Falls observes the normal direction common to all the great axes of the region, until it approaches the openings on the Otto White-Ash Seam above described. From these, as it expires E., it seems to be deflected 10° N. of its previous course, and causes a sharp curvature in the Grey-Ash Seam in the water-level gangway, and a counter-level under cover of high ground. From the water-level gangway on the N. dip of this axis, communication was made 870 yards from the York Tunnel, across a narrow basin rising W. with the old W. gangway on the same bed, dipping S. It appears, therefore, that we have at this point the W. extremity of the basin of the York Tunnel as affecting this bed. On the S. side of the anticlinal axis the gangway pursues a devious though general S.W. course for 750 yards to a slope, following the coal below water-level in the direction of dip S. 35° E., the angle of dip 20°. Leaving, for the present, the water-level gangway, and descending with the slope 60 yards, we find the dip diminished to 8°. Sixty yards still farther down the slope it again augments to 16°. At both these levels, gangways are driven E. upon the bed. The lower gangway, 180 yards E. of the slope, is deflected N. a short distance, and again resumes its course; but 300 yards from the slope the joint effect of a small anticlinal subsiding W., and a synclinal rising in the same direction, affords opportunity for three gangways to diverge—one turning S., to pursue the S. side of the anticlinal; one observing the N. side, the dip of which, amounting to 11°, is common also to the basin; and a third, driven N.E., following the gentle S.E. dip of a basin which is widely expanding and rising towards the W. This branch gangway is driven 350 yards; the two preceding, 100 yards each. The upper level of the slope is slightly affected by the prolonged rise of the basin (which also causes the gentle dip of 8° *in* the slope); but its general course is nearly parallel to the water-level gangway, and it has been worked 700 yards N.E., or nearly to the axis of the great anticlinal. It is impossible to estimate the full significance of the presence of this small anticlinal, which causes the branching of the gangways; whether it becomes important farther E. and represents axis (**M**) on West-West Branch, is a question the future must determine.

Westward from the slope the water-level gangway and the two slope-levels, as far as they have been driven, come under the influence of a synclinal basin, which, observing the normal direction, rises and expands so rapidly towards the W. that its effects are entirely lost on the flank of the axis of the Falls: nor is this all, for, as we will presently show, an anticlinal (**N**), the axis of which ranges parallel and about 100 yards S. of that of the basin while drooping E., rises and flattens out towards the W., so that we are nowhere able to discover its identity as a distinct flexure, unless we choose to regard that anticlinal ranging S. of Fisher's Basin as a Western extension of the same. The effect of the gradual obliteration of the N. dip, common to the saddle and the basin, is a great expanse of lower measures having a general S.E. dip. In the water-level gangway the rise of the basin is encountered 225 yards S.W. of the slope. From this point the gangway observes an E. course 275 yards to the entrance, from which, driving in a direction contrary to that we have been tracing, the strange developments we have been describing were made. A gangway at a higher level on the breast bends round the basin, and comes out at the surface on the opposite dip. At the drift-mouth of the water-level the dip of the coal is vertical N. Twenty yards E. of this a shaft is sunk 45 yards on the coal, and gangways are driven. W. of the shaft 150 yards, the rise of the basin is encountered at the gangway level. The coal is mined round on the S. dip 100 yards, until it meets the bottom of the slope prolonged 192 yards below the water-level gangway. E. of the slope the lower gangway is driven 450 yards on an average dip of 14° S. E. from the shaft a gangway

is driven on the vertical dip 550 yards to a tunnel cut S. 100 feet across the axis to the coal on its S. side, dipping 45° S. From this tunnel a gangway is driven 350 yards W. At the face or far-end of this gangway it is 450 feet to the gangway on the N. dip. Above water-level on this S. dip the coal was wrought by drift many years ago.

The following section represents the subdivisions of the Otto Grey-Ash Seam, when fairly developed:—

Coal, 2 feet; Coal, 3 feet; Bony Coal, 2 feet; Coal, 2 feet; Dirt, 2 inches; Coal, 3 feet 6 inches.

It is comparatively free from fault, though the average thickness of marketable coal in the bed is hardly so great as we have stated.

The shipments from the Otto White-Ash Colliery in 1857 amounted to 49,778 tons; from the Otto Grey-Ash, 55,214 tons. The capacity of the two mines for 1858 is estimated at 130,000 tons.

Branchdale Colliery (page 176 of text)—Dewart Lands—Lessee, C. C. Boyer (formerly Macdonald).—The slope is sunk on the S. dip of a saddle (**P**) of the Spohn Coal-seam at an angle of 35°; length of slope, 350 feet. From the foot of the slope a gangway is driven 300 yards E. In the opposite direction the gangway pursues a W. course for 850 yards, where the coal is squeezed out. E. of the fault a slowly-rising gangway is opened obliquely up the breast 250 yards, and a level gangway is driven some distance W. until it swings round the point of the declining saddle. The rising gangway crosses this saddle, which dips 4° W., and is worked 400 yards E. on the N. dip until it is affected by a basin rising E., which causes the level to swing off to the N. The breasts from the gangways we have described communicate with the old counter-level gangway of Macdonald, which curved round the point of the saddle and the basin. The bed averages, when sound, from 4½ to 5 feet of coal.

An attempt was made to reach higher coals by a tunnel driven S. from the gangway 700 yards W. of the slope. This tunnel, 285 yards long, cut three small dirt-beds, but no coal of workable value.

SWATARA.

Swatara Colliery (page 178 of text)—Lessees, Brown & White—Forest Improvement Company's Lands.—The upper mines consist of two drifts entering at water-level on the N. side of the great anticlinal (**M**) of the Swatara Falls. The seams wrought correspond in relative position and character to those mined in Fisher's Basin, S. of the Falls axis. The N. drift follows the bottom slate of the upper coal of Fisher's Basin, or the "Red-Ash Vein"—so called because one of its benches yields a Red Ash—on the horizon of the Forestville Seam. The gangway pursues a W. course 400 yards, when it is deflected N.E. by the rising basin of the coal, in a uniform direction as far as wrought, or 400 yards on the S. dip. The N. dip at the mine-opening is 25°; it declines gradually to 8° at the end of the basin, and on the S. dip rises to 30°. The thickness of the seam is 10 feet.

The gangway in the lower bed on the N. dip of the basin ranges parallel to that in the upper, 35 yards distant. It is in like manner affected by the heading-up of the basin W., and sweeps round to the E. a fourth of a mile from the mine-mouth. The thickness of this seam, known as the "Little Vein," is from 5 to 6 feet.

It is worthy of remark that the gangways on the S. side of the basin lie precisely in the range of the gangways driven W. from Muddy Branch, on coals doubtless the same as those flanking the N. side of the Falls anticlinal.

Brown and White's lower mines are situated in the synclinal known as Fisher's Basin, lying S. of the Falls axis. The coals wrought are the same we have shown above; they are exhibited in the Swatara Section. On the lower seam two gangways are driven W. at different levels on the N. side of the basin—one on the S. dip, and one in the centre of the trough. As the basin sinks or deepens W., the latter gangway, preserving its level, branches 140 yards from the entrance, the branches following the coal on the opposing dips. The transverse ravine of Big Creek, 800 yards W. of the drift entrances, cuts out the coal of the upper breasts on both sides of the basin; but one gangway on the S. dip passes under the stream. W. of the Creek the coal has been worked 400 yards. The extreme width of the basin from outcrop to outcrop, where the ground is highest, is 1100 feet. The N. dip of the basin at the Swatara is 25° or 30°. W. of Big Creek it augments to 70°, and rapidly falls off

to 9° near the W. end of the gangway. The N. dip is quite uniform from 10° to 20°. The coal in this mine averages 6 feet in thickness.

The Upper Coal, or Big Vein, is wrought in a manner quite similar to the preceding. The mining of this bed demonstrates the fact that the bottom of the basin does not sink W. except for a short distance near the E. end. For this reason a gangway is opened along the axis, and coal is wrought from the breasts on both sides. The coal is mined W. 1200 yards. The subdivisions of the bed are as follows :—

Shelly coal, 1 foot; Coal, 5 feet; Coal, 3 feet; Bone Coal, 1 foot; Coal, 2 feet.

The shipments from this colliery, in 1857, were 93,388 tons.

Oliver's Colliery (formerly M'Creary's)—Forest Improvement Company's Lands.—This colliery is based upon the seams wrought by Brown and White, though lying on the S. side of the anticlinal (**N**) ranging S. of Fisher's Basin. On the W. side of the Swatara, the lower or "Little Vein" only is wrought above water-level, the Big Vein or Red-Ash Seam having been driven Westward 1500 yards. The Little Vein, dipping 40° S., is mined 260 yards W. The seam is somewhat thinner and less pure than in Fisher's Basin.

On the E. side of the Swatara the Big Vein or Otto White-Ash Bed is wrought from two gangways on the breast above water-level; the upper gangway 500 yards, the lower 750 E. The coal on the upper level, 100 yards E. of the drift-mouth, is influenced by a small wrinkle, which caused the gangway to turn N. for a short distance. A far more important flexure affecting the dip is encountered at the E. end of the upper gangway. At this point the anticlinal (**N**) S. of Fisher's Basin seems to expire, as it affects this coal, rapidly to the Eastward, causing a sharp turn at the gangway-level into E., and finally into a N. dip. The coal at this point is faulty and confused. This has caused a suspension of work in this part of the mine; but as the W. gangways from the Otto Mines on the same bed stopped in a fault but a short distance to the N. on South-dipping coal, it appears evident that a small basin intervenes, which, rising Westward, would cause a reverse curve of the gangway before it could resume an Easterly direction on the S. dip. The lower level seems to be experiencing the influence of the same disturbance. At this level a division in the bed occurs a fourth of a mile E. of the drift-mouth by the intercalation of a stratum of slate of too great thickness to be cut away. The gangway divides at this point; but in 500 feet distance, the rock having thinned away, the two branches reunite into one. In the upper level no such division occurred. The average normal dip of the bed is 35° S. In thickness it corresponds nearly to what we have seen of it in Fisher's Basin.

Fisher's Basin seems to have expired so rapidly to the E. by a flattening-out of the dips, that its effects are not traceable on the E. side of the Swatara, and every attempt to find it developed as a basin of coal has failed. We see exhibited here the fact of a synclinal and anticlinal flexure, both expiring so rapidly in the same direction as to develop only a trifling subsidiary change of dip on the flank of the great anticlinal of the Swatara Falls.

The yield of Oliver's Colliery, in 1857, was 9638 tons.

J. C. White's Colliery (Forest Improvement Company's Lands).—The seam here wrought crops out at water-level 150 yards S. of Oliver's Big Vein. It is regarded as the "Grey-Ash Vein" of the Otto Mines. Dip, S. 45°. Gangways are driven at water-level 800 yards W., and 750 yards E. The subdivisions of the seam, under favourable circumstances, in the W. gangway are as follows :—

Coal, 6 feet 6 inches; Dirt undermining, 2 inches; Coal, 1 foot 8 inches; Dirt, 1 foot 2 inches.

In the E. gangway the following section was taken near the face of the gangway :—

Coal, 4 feet; Bone, 1 foot; Dirt, 1 foot; Shelly Coal, 3 feet.

A slope was recently sunk 80 yards on the same bed below water-level. In 1857, 23,369 tons of coal were shipped.

Dundas Colliery, No. 6, Sharp Mountain, E. of Tremont, or Bettinger Tunnel (Lessee, John Doherty).—This tunnel, 2½ miles E. of Tremont, enters Sharp Mountain 80 yards above water-level, and intersects six beds of coal, viz. :—

185 feet to 5-feet bed; dip, 30° S.; not worked. + 215 feet to 6-feet soft coal; dip, 36° S.; gangways, 300 yards E. and W. + 76 feet to 2-feet bed; dip, 52° S. + 120 feet to 4-feet bed. + 170 feet to 10 or 12 feet bed; dip, 45° S.; gangways, 300 yards E., and 250 yards W. + 120 feet to coal, subdivided by 2 feet 6 inches of slate into an upper member 6 feet thick, and a lower 2 feet 6 inches thick: this seam dips 45° S. The last two seams only are mined by gangways E. and W. The tunnel is now being prolonged Southward to other beds of coal.

MIDDLE CREEK.

Woodville Colliery (page 179 of text)—L. S. Spangler—situated on Middle Creek, in and immediately S. of the Westward prolongation of Fisher's Basin.—The Ten-feet Seam of the Donaldson Section has been wrought in the centre of the basin on the E. side of Middle Creek. 50 yards E. of the mine-entrance the basin deepens so rapidly as to require two gangways to give access to the coal on its two sides. The N. dip of the basin is 15°, the S. dip 25°. The N. gangway is 400 yards long; the S. gangway 300 yards, to a point at which it bears off Southward around an anticlinal subsiding Eastward. At this point, along the E. dip, a slope is sunk 85 yards, and gangways driven a short distance W. in the basin, and S. on the saddle.

On the S. side of the saddle the same bed is now wrought from Middle Creek at water-level: it dips 35° S. The gangway is driven 60 yards E., the dip growing flatter as it advances. The seam contains 7 or 8 feet thickness of coal. It is subdivided by slate sometimes 2 feet thick. On the W. side of the Creek a gangway is wrought 1000 yards W.

The Big Seam of Donaldson is wrought at water-level on both sides of Middle Creek. The gangway W. runs 1300 yards, the gangway E. 400 yards. On the W. side the seam is 20 feet thick, including the usual middle slate. On the E. side the whole seam dwindles to 8 feet thickness.

The Black Heath and "Primrose" (Black Valley) seams have also been wrought; the latter by gangways E. and W. at water-level, the former by a gangway W. It is reached by a tunnel from the Primrose gangway driven 26 yards N. Dip, S. 40°. It is proposed to sink a slope on the Big Seam during the present season. Shipments from this and the Spohn Colliery at Tremont, for 1857, 30,514 tons.

DONALDSON.

Broad Mountain Colliery (page 181 of text)—N. of Donaldson—R. H. F. Horton.—A tunnel, of which, so far as it was completed at the time our measurements were made, we have elsewhere presented a Section, is driven Northward into Broad or Thick Mountain. This tunnel intersects all the important lower seams of the Donaldson Section. From the entrance it is 141 yards long to the "Primrose" (Black Valley) Seam; 174 yards to the Black Heath Seam; 268 yards to a 4-feet seam; 288 yards to the Big Seam; and 384 to the Ten-feet Seam. Between the last two important beds two small impure beds were passed; the lowermost of these is known as the "Iron-ore Coal." The dip of the beds ranges from 50° to 60° S.

The Primrose Seam, which has yielded from 5 to 7 feet thickness of coal, is driven 1700 W. The Black Heath Seam varies in thickness from 3 to 12 feet. It has been wrought 480 yards E., and 1320 yards W. The Big Seam, the only one now wrought from the tunnel, is driven 500 yards E., and 1850 yards W. It is subdivided by a slate of variable thickness, between 6 inches and 6 feet, into an upper bench of 12-feet coal, and a lower one of 9 feet 5 inches. In common with all the others, it is more or less liable to compression, and consequent faulty structure. The Ten-feet Seam measures 10 feet in thickness, inclusive of a middle bench of bone coal and slate 2 feet thick.

The Big Seam is mined below water-level from a slope sunk 185 yards from the surface. The slope intersects the tunnel gangway 4 yards W. of the tunnel. Dip, 54° at top and bottom, 64° midway. Gangway, 600 yards W. and 400 yards E.; dip, 70° at the end of W. gangway. From the gangway, 200 yards W. of the slope, a tunnel is now being driven Northward to cut the Ten-feet Seam.

A new slope is sunk on the "Primrose" Seam about 150 yards E. of the tunnel. Length below surface, 110 yards; S., dip 54°. Gangways are started from the slope. It is designed to tunnel N. from the gangway to the Black Heath Seam.

Shipments in 1857, 58,838 tons.

Spohn Colliery (page 183 of text)—L. S. Spangler—near Tremont.—The two main N. and S. anticlinal flexures of the Little Lick Mountain drooping Eastward, and the included basin rising Westward, have very materially affected the simplicity of the mine at this colliery. A drift enters at water-level, and follows a small slate-seam, 150 yards Westward, dipping N.; a tunnel is then cut 40 yards S to a "Four-feet" seam of coal, dipping steeply N.E. from the subsiding main Southern axis of Little Lick Mountain. Followed Westward 25 yards, the saddle rises so rapidly in the same direction as to throw off the coal on its flanks, dipping N. and S. The S. gangway, driven 900 yards W., is deflected Southward owing to the Westward rise of the basin included between the anticlinals of Little Lick and Red mountains, and swings round to the S. side of the basin.

The N. gangway is driven 400 yards Westward to the rise of the basin between the anticlinals of Little Lick Mountain; it then swings Northward and Eastward, until, in a short distance, it sweeps round the N. saddle and again ranges Westward. On this N. side of the Northern axis Mr Eckel has penetrated to the seam by a tunnel at a higher level than Spangler's Gangway, and has driven the gangway Westward, until it begins to turn Northward under the effect of the Westward ascent of the basin between Little and Big Lick mountains.

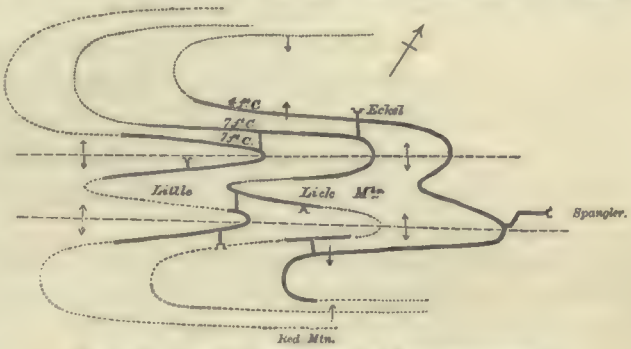


FIG. 313.—Diagram of Spangler and Eckel's Gangways.

From the "Four-feet" Seam, Eckel's Tunnel is prolonged 64 yards S. to the "Seven-feet" Seam. This bed was wrought Westward and Eastward round the Northern anticlinal. The same bed is entered by Spangler from his S. gangway on the Four-feet Coal, but it proves too impure to mine at that point. It has been wrought to a limited extent on the N. side of the S. axis by a tunnel from the surface.

From Eckel's Gangway, on the Seven-feet Seam, and also from several points on the surface, tunnels are driven to a still lower seam of coal than the preceding. It is locally known as the "New Seven-feet" Seam, or Wolf's (see Plate VII.), and is affected by the several flexures of the mountain in a manner precisely similar to the beds already described. The extraction of coal at the colliery is now entirely confined to a gangway on that part of the bed which dips Southward from the Southern axis of Little Lick Mountain. The Four-feet Seam has yielded, on an average, 4 feet thickness of coal; the two other seams about 5 feet each.

RAUSCH CREEK.

Mount Eagle Colliery (page 184 of text)—H. Heil and Co.—The great anticlinal of Little Lick Mountain, which enters the coal-field from the Williams Red-Shale Valley at "the Kettle," as it droops slowly Eastward, is arched above water-level by higher and higher measures, until, on Rausch Creek, the Great Upper Egg-Conglomerate descends beneath water-level, and the "Ten feet" and "Big" coal-seams of the Donaldson Section repose under high ground on the E. side of the creek.

At Heil's Colliery, a tunnel starting from the surface, near the outcrop of the "Ten-feet" Seam, is driven a few degrees E. of N. 100 yards, through higher and higher measures to the Big Coal, which dips 30° N. 10° E. In the tunnel several thin bands of coal and coaly matter were passed. The Big Seam includes an upper bench of coal from 10 to 12 feet thick, separated, by slate from 9 to 12 feet thick, from the lower coal 6 or 8 feet thick. Portions of the seam are wrought from parallel gangways, except where the intervening slate becomes so thin as to admit of being readily cut away. When the slate is thin, the coal is correspondingly thick.

From the tunnel, parallel gangways are driven South-Eastward, but they gradually deflect more and more S. as the coal sweeps round the point of the saddle to take its position on the S. side. The gangway on the upper bench is 400 yards long; on the lower, 300 yards. In the opposite direction from the tunnel two gangways are driven on the N. dip of the coal 300 yards, when the slate division becomes thin, and is cut away, one gangway only being pushed forward. This is driven 500 yards. At the present date some symptoms of a turn of the gangway towards the N. begin to manifest themselves. It is not improbable that such a change of

direction will actually occur, as the coal may be affected by the shoaling or rising Westward of the basin included between the double anticlinal flexure of Little Lick Mountain, as we have seen to be the case with higher coals near Tremont.

An extension of the tunnel to higher seams is now in progress. The Black Heath Bed, it is expected, will be reached in 150 yards.

Shipments in 1857, 44,433 tons.

Lorberry Creek—Wheeler and Miller's Colliery.—From Rausch Creek, the Big Seam is indicated by an outcrop on the S. side of the anticlinal of Little Lick Mountain to the valley of Lorberry Creek. At the head of this valley a tunnel is driven 130 yards N. to it. Several unimportant coal-seams were cut in the tunnel. The prevailing subdivisions of the seam in this mine are as follows :—

Coal, 5 feet; Slate and Dirt, 2 feet 6 inches; Coal in four benches, 12 feet.

Dip 30° S. From the tunnel a gangway is driven E. 1600 yards. In this gangway, 500 yards E., the coal was compressed and shelly for 200 yards.

A slope is now being sunk from the gangway 60 feet E. of the tunnel. This slope descends obliquely upon the dip at an angle of 25°. It will be 200 feet long to the level of Kitzmiller, Stees, & Co.'s old gangway.

Shipments in 1857, 22,248 tons.

Kitzmiller, Stees, & Company's Colliery. — On the S. side of the basin opposite the colliery last described, the Big Seam has been wrought at water-level, and is now mined from a slope below water-level. The water-level gangway, following the coal W. on a N. dip of 30°, when 700 yards from the entrance, turns N. round the rising basin of the coal, and ranges E. nearly to Wheeler and Miller's Tunnel. The E. dip in the basin is 18°, the S. dip 30°. Width of the basin, about 500 yards.

The slope is sunk on the N. dip, near the drift-mouth. It is 100 yards long, dip 30° at top, 35° at bottom. The gangways are driven 320 yards W. and 180 yards E. In the slope the seam is 17 feet thick; but the middle bench of slate and dirt is 5 feet thick, and the lower coal consequently thinner than in the water-level gangway.

Shipments in 1857, 12,655 tons.

The anticlinal of Red Mountain ranges a short distance S. of the colliery. The Big Seam has been proved on its S. dip, but the subsidence of the arch E. carries it below water-level on Rausch Creek, as our section shows.

Sharp Mountain Colliery (page 186 of text)—Charles Molley & Co.—E. side of Lorberry Gap of Sharp Mountain.—Slope sunk 80 yards on the Umberhauer Red-Ash Seam, at an angle of 65° S. Gangway E. 350 yards and W. 300 yards.

The coal varies in thickness from 18 inches to 3 feet. It is underlaid by Bone coal and slate, and capped by dirt "undermining." In parts of the mine the coal has been compressed to a thickness of a few inches by irregularities in the top rock. The length of breast worked is 65 yards to water-level.

Shipments in 1857, 7240 tons.

The Dauphin Coal-Basin is now entirely deserted by coal miners; for several years little or no coal has been shipped from it. So unreliable do the seams prove, and so great is the outlay required, that, recollecting that former experiments have failed, no disposition at present is manifested to develop its resources.

BEAR GAP.

Wiconisco Coal-Basin, Bear Gap (page 189 of text).—In the Wiconisco Coal-basin at Bear Gap, two companies are engaged in the mining of coal, the Lykens Valley Coal Company, and the Short Mountain Coal Company. The operations of these companies are now entirely confined to the two lowermost seams of Lick Mountain, known as Nos. 1 and 2. The former company mine E. from the Gap, the latter company W.

Lykens Valley Coal Company's Mines (Superintendent, Mr Hoffman).—The lowermost, or No. 1 seam of the Bear Gap, situated scarcely 100 feet above the Umbral red shale, is followed by a slope sunk 90 yards N. at an angle of 45° at the top, declining to 18° at the bottom. From the foot of the slope a tunnel is driven 76 feet N. to the overlying No. 2 seam. In this tunnel, 30 feet above No. 1, a seam of coal-dirt 5 feet thick is cut.

Upon the No. 1 seam a gangway is driven E. from the slope 372 yards. A small double roll occurs 142 yards from the slope, which throws the seam 24 feet S. of its previous line. Upon the No. 2 seam a gangway is driven 68 yards W. and 600 yards E. In this gangway, 60 yards E. of the tunnel, the seam makes an offset S. 30 feet to the dirt underlier, with which it ranges E. No marketable coal has yet been obtained from the No. 2 coal in the slope. The bed varies from 8 to 12 feet in thickness, without dividing-slates; it is almost immediately overlaid by pea and nut conglomerate. A new slope is about to be sunk on the No. 2 seam. The No. 1 bed is between 5 and 8 feet in thickness. Both seams have been wrought very extensively above water-level by the Lykens Valley Coal Company. The Big Seam has been driven a mile and seven-eighths E. from the Gap. The lower seam is also wrought in the same direction, but it is generally too soft to bear transportation. By the thinning of the intervening strata 3600 feet E., the two beds approach within two feet of one another, and range forward as one great bed. The breast or slant length of these seams above water-level, from the Gap E., is said to exceed 500 feet; dip, 45°. They outcrop on the S. slope of the Lick Mountain, about 300 feet below the summit. On the N. side of the North or Bear Mountain, the same seams are proved about the same distance below the crest, and but a little way above the red-shale alternations. At this point the seams are somewhat thinner.

Shipments, in 1857, 65,202 tons.

Short Mountain Coal Company's Mines (page 191 of text)—Superintendent, A. B. Young.—The mines of this Company are situated in the Short Mountain, or prolongation of the Lick Mountain W. from Bear Gap. The general strike of the measures is S. 78° W. for two miles, to the high notch of Big Run, at which, owing to the effect of a double anticlinal flexure throwing E. dips into the valley, the trend of the coal-seams is N. 12° W. for 300 yards, and is again almost due W. for 1½ miles to the extreme W. end of the basin, from which the outcrop follows the N. side of Bear Mountain E. The only seams of profitable value traced through this range of country are Nos. 1 and 2, already wrought to a great distance E. At Big Run Gap, and at the extreme W. end of the basin, openings are made in both beds, which are mined to a small extent for the supply of farmers. At Bear Gap the Big Seam (No. 2) is entered by a drift above the water-level, and a gangway is driven W. 1670 yards. At convenient points tunnels are driven S. to the No. 1 seam, upon which gangways are driven parallel, and equal in extent to the former. The intervening rock is generally a dark-blue or black shale, sometimes very silicious and hard; it varies in thickness from 8 to 30 feet. Near the Gap, on a dip of 28° N., the breast is 170 yards long, but at the end of the gangway, where the dip is 18°, though steeper towards the outcrop, the breast is 270 yards long. On account of the length of breast, and the gentle character of the dip, self-acting planes are constructed inside of the mine—four on each seam—upon which the empty cars are raised sidewise on a safety-truck, and at suitable points pushed into the chambers, which are cut out along the dip at right angles to the planes. Frequent bulges or convexities in the bottom slate, causing curvature of the gangways and breasts, occur in the mine. The prevailing thickness of the seams is about the same as we have already noted. It is a somewhat singular circumstance that the two beds are rarely both in a sound condition in the same neighbourhood; one is usually soft and dirty when the other is hard. This is also true of the same beds going E. The No. 2 coal is considered superior in quality to the lower bed.

Shipments in 1857, 56,538 tons.

The tunnel driven N. across the centre of the basin opposite Bear Gap has been abandoned these seven or eight years. It is cut 1110 feet to the Hoffman Coal; and from the gangway on this bed 500 feet E., is prolonged 200 feet through several thin seams into the conglomerate. The only seams wrought to any extent are the Etting and Pat Martin. Neither of these is certainly recognisable in the tunnel, where the measures are greatly confused and broken up, but the former was cut by a short tunnel driven S. from the "air-hole coal" about 500 feet E., and the latter by a second tunnel driven S. from the Etting seam. The Pat Martin is worked about two-thirds of a mile E. of where it was struck, the Etting a mile E. Driving W. on the Etting seam, the gangway turns S., then E., and finally S. again, owing, in the first instance, to the rise of a basin W., and in the last, to a saddle drooping E. This tunnel was driven and used for years by the Lykens Valley Coal Company; but the experiment was a costly one, and proved unprofitable.

About 4 miles E. of Bear Gap an attempt is now being made on the Beuhler lands to tunnel N. through the Lick Mountain to the Coal-measures. The experiment is a hazardous one.

MINE-HILL VALLEY.

Wm. Richardson's Colliery—located on Wolf Creek, E. of Mill Creek Gap, in the second basin N. of Mine Hill.—A perpendicular shaft is sunk in the centre of a synclinal basin, through sand and debris 75 feet, to the Jugular Bed. The upper portion of this great bed seems to have been swept away, leaving a band of coal divided by slate variable in thickness, the average yield of which is 12 feet of coal. The dip of the coal on the N. side of the basin is perpendicular, or rather N.; on the S. side the dip is gentle. The basin rises gradually to the E. From the rising gangway, 250 feet E. of the shaft, a tunnel is cut N. 75 feet, to a lower coal-bed 3½ feet thick. This seam has been mined at water-level on the slope of Broad Mountain. Two other seams, one 7 feet 6 inches thick, lying 100 feet N. of it, and another, 150 feet lower in the series, have been mined above water-level on the flank of the Broad Mountain. These seams dip nearly vertically opposite Mill Creek Gap of the Mine Hill, but flatten as they range E. to sweep round the rising basin of the Big Coal.

No coal has been shipped from this mine for several years.

Repplier's Colliery (page 202 of text)—Lessee, George S. Repplier (formerly Lawton), situated on the N. side of Mine Hill, at Mill Creek Gap.—This slope descends W. upon the bottom slate of the great Johns' Bed (provisionally termed the Jugular), as the basin of that coal rises Eastward. The inclined plane does not follow the axis of the basin, the bearing of which is S. 70° W. Length of slope to first level, 401 feet; to lower level, 996 feet. The dip is 21° in the upper lift, and 19° in the lower. The upper-level gangways sweep round the end of the basin into regular N. and S. dips. On the S. side of the basin, 600 feet from the slope, a cut extends Northward through the 7-feet coal-bed, here quite thin and unimportant, 235 feet to a 2 feet 6 inches bed, which was previously supposed to be 11 feet thick. It was struck at the centre of the rising basin. Its regular N. dip is 46°, the S. dip 29°. The bed was mined on both sides of the basin to a limited extent, and is now abandoned.

The lower gangways from the slope curve similarly to the upper, keeping the bottom slate of the coal as it dips W., S.W., and S. on the one side of the slope, and N.W. and N. on the other. Where the normal S. and N. dips first set in, the gangways ranging W. are 400 feet apart; whereas 2000 feet W. of the slope, the present limit of the workings, they are 240 feet asunder. This is due to the contraction of the basin and the increased steepness of the dips in that direction.

Newcastle Colliery, in Kelly's Hollow (page 203 of text)—A. Hexter & Co. (formerly Fogarty & Kelly)—situated in the second basin N. of Mine Hill, W. of Mill Creek Gap.—The upper-level workings (now abandoned) were begun by a drift cut Westward upon the bottom slate of a great bed of coal dipping 25° S.W. of the entrance 250 feet: a cross-cut was made through coal 190 feet to the top slate; the latter was passed through by 20 feet of tunnel to a second bed, dipping steeply S. These seams form a sharp synclinal basin, and rise again to meet the cross-cut prolonged to the lower bed, which dips 56° N. Gangways are driven W. upon both sides of the basin of the lower coal and on the S. dip of the upper. The S. dip of the lower bed in the main gangway is pretty uniform, whereas that of the upper varies greatly in the same direction; it is very gentle 500 W. of the cross-cut, whereas 1000 feet W. it is nearly vertical.

The new opening at these mines is a tunnel cut N. 30° W. from the surface 65 feet below the level of the old cross-cut. The basin of the lower coal is 8 feet above the tunnel-level 510 feet from the mouth. In driving this tunnel an anticlinal was passed 160 feet S. of the axis of the basin. On either side of this arch three small coal-seams dip opposingly; but a fourth seam, comprising 8 feet of coal and slate, overlying the smaller beds on the S. dip, was not found on the N. The rocks intervening between the smaller seams are much thinner on the N. than on the S. side of the anticlinal axis; whether there is a similar though far greater thinning of the strata lying above and below the 8-feet seam, so as to cause that bed to merge into the great lower bed in the basin with but a thin division of slate, or whether the 8-feet seam swells out into the enormous mass of coal which is wrought at the tunnel, are questions which, in the present state of the mining, do not admit of solution. From the tunnel-mouth it is 100 yards S. to the outcrop of the great seam dipping S. into the gangway of Repplier's

(Lawton's) Mine. It seems evident, therefore, that we must regard one or other of the large beds in the basin as the Repplier seam, or else suppose the Repplier Bed the equivalent of both, exclusive of the addition of the 8-feet slaty bed of the tunnel.

The long-vexed question of the existence of horizons of deposit of two great White-ash beds at the base of the Coal-measures in this part of the coal-field may, in the future, be settled to the satisfaction of all by the further extension of the mining at this colliery.

So far as we have present facts, the synclinal axis in the tunnel seems to deepen Eastwardly.

Amount shipped, in 1857, 2062 tons.

Patterson Colliery—Wm. Littlehales & Son—situated on the Slope of Broad Mountain, half a mile E. of Miller's Pine-Knot Slope Mine.—There is a drift 75 feet above water-level on the Jugular Bed, dipping 45° S. The main gangway is driven E. 500 yards on the bottom slate of the coal. The thickness of the seam is exceedingly variable, but the following will represent its subdivisions :—

Coal, including thin slates, in some places exceeding 30 feet, in others entirely absent ; Slate, 6 feet 9 inches ; Coal, 1 foot 6 inches ; Bony Coal, 8 feet 12 inches : (these divisions are at times represented by 3 or 4 feet of slate and dirt) ; Bottom Coal, from 5 to 6 feet.

About 350 yards E. of the mine-entrance the upper division is separated from the lower by the intercalation of a stratum of conglomerate rock. A branch gangway follows the great upper bed : in working the breasts upon this, the overlying slate is occasionally so thin as to fall, bringing with it 3 feet of coal from an upper seam. The lower division of the bed wrought from the main gangway does not exceed 6 feet thickness of sound coal : it is underlaid by pebbly sandstone.

In a drift on the same level mined W. 300 yards, the seam was quite regular ; no rock was found in it, and the slate division does not exceed 2 feet.

Yield, in 1857, 14,247 tons.

Pine Knot Colliery (page 204 of text)—Lessee, Charles Miller (formerly, Adams & Miller)—situated on the S. Slope of the Broad Mountain, E. of West Branch Gap of Mine Hill.—The slope descends S. with the middle benches of the Mammoth Coal-bed, the bottom slate of which is followed only through the lower part. Length, 120 yards. Dip of coal, 40°. The gangways E. and W. from the slope are each upwards of a mile in length. At the foot of the slope a tunnel is driven S. 92 feet to the Lelar Coal, which is from 5 to 7 feet thick, and is prolonged 107 feet to the Crosby Bed, from 9 to 14 feet thick. These beds have not yet been mined.

A new slope is sunk 100 yards from the outcrop to the end of the W. gangway from the old slope. The inclination of the Mammoth Bed at this mine is 44° S. From this slope a tunnel S., 220 feet long, is cut to the Crosby Coal, passing through the Lelar, both dipping S. somewhat more steeply than the Mammoth. E. of the Pine Knot Slope the Lelar Coal is sometimes found separated from the Mammoth by so thin a partition of slate as to admit of being mined at the same time. The Mammoth Seam, the normal thickness of which is 20 feet, varies greatly in the same direction. It has been developed as a mass of coal exceeding 60 feet in thickness ; but under these circumstances, it is shelly, and more or less impure. W. from the Old Slope the coal-seams are more regular and uniform in thickness, and the intervening measures are thicker.

The yield of the Pine Knot Colliery, in 1856, was 34,497 tons ; in 1857, 22,767 tons.

Lewis Dougherty's Mine at the Mine Hill Gap, and Hill's Tunnel, a mile W. of the gap, are both abandoned.

Kear's Mammoth Colliery (N.W. side of West Branch Gap)—Slope sunk on the bottom slate of the Daniel or Mammoth Seam 120 yards below the surface. Dip 50° at the top, increasing to 80°, and decreasing at the bottom to 50°. Gangway driven 50 yards E. and 1600 yards W. From the foot of the slope a tunnel is driven 37 yards N. to an 8-feet seam, dipping 50° N. : upon this a gangway is driven 150 yards W.

The Mammoth or Daniel Bed in this mine averages fully 20 feet in thickness. Except an occasional layer of Bone coal or thin slate, there are no impurities in the bed. It is sometimes as much as 30 feet thick.

Jugular Colliery (page 205 of text)—John M'Ginnis—situated on the S. Side of the Broad Mountain immediately opposite Kear's Slope on the Mammoth Seam.—The slope is sunk 57 yards below water-level on the

bottom slate of the Jugular Seam, dipping 45° S. At the bottom of the slope the coal was only a few inches thick on the E. side, but on the W. side it was 4 feet thick, and in the gangway increased steadily to 28 feet. In the breasts opened W. its thickness is pretty uniform; but in the gangway it is variable. The gangway is driven W. 275 yards. The old workings on the coal above water-level W. have been on fire 19 or 20 years.

The Jugular Seam has been worked E. on the breast above water-level more than 400 yards. In this drift the bed sometimes exceeds 30 feet in thickness. The tumbling or dirt-bed occasionally approaches the Jugular so nearly, by the thinning of the measures, as to fall into the breasts on the latter bed. At water-level the Jugular is cut out by rock.

The yield of the colliery in 1857 was 8163 tons.

Heckscherville Colliery (page 207 of text)—Lessee, E. Borda.—The present and former workings of this colliery are very extensive. The avenues to the coal embrace a water-level tunnel, two slopes and two tunnels below water-level.

The water-level tunnel, formerly known as Paine's, penetrates the Broad Mountain, which it enters 150 feet above the level of Mine Hill Gap, nearly opposite Taylor & Volpert's* Colliery. A section of the strata cut by this tunnel has been already presented. The only seams wrought from the tunnel are the Daniel and the Jugular. Upon the former, gangways are driven nearly 2000 yards W.; upon the latter, 1700 yards. A counter-level gangway, entering the Jugular Seam from a ravine half a mile W. of the tunnel, extracts the upper breast of the coal: it is 800 yards long.

One hundred feet E. of the tunnel a slope is sunk on the Lelar Bed, a seam of unimportant thickness next overlying the Daniel Coal; length of slope below tunnel level, 205 yards, dip 45° S. at top, augmenting to 50° at bottom. The Crosby Seam, ranging 12 yards S. of the Lelar, is tunneled to from the foot of the slope. From the gangway on this bed, 55 yards W. of the slope, a tunnel is driven N. across the Lelar Coal 73 yards to the Daniel Seam, dipping 47° S. In the opposite direction a tunnel is cut 41 yards to the "New Vein" coal, dipping 58° S., and is prolonged 53 yards to the Church Seam, dipping 60° S. W. of this tunnel, 42 yards from the Church Bed, a cross way is cut 10 yards S. to communicate with a vertical shaft sunk 40 yards from the surface. This shaft is designed to drain the constantly-extending underground gangways of the mine: it is fitted with a variety of the Cornish "Bull" Engine, and two pumps designed to lift 326 gallons of water per stroke.

In sinking the shaft a small seam, commonly called the Red-ash Bed, was cut. From this shaft a tunnel was driven S. to cut this seam; but, contrary to expectation, the dips of the measures changed 30 feet S. of the shaft, and the coal which basins at a higher level was not struck. The opposing dips amount to 45° on either side of the synclinal. The presence of this synclinal about 300 yards N. of the outcrop of the same measures on the S. side of the valley bordering Mine Hill, has raised the question whether the anticlinal of Peaked Mountain, the topographical indications of which expire three-fourths of a mile to the W., will not materially influence the simplicity of the general basin, and in the future affect the deep workings of the lower coals. Looking to the steepness of the N. dip of the strata and the known persistency of great anticlinal flexures in the strata after their effects are topographically lost, we can hardly hesitate to infer that the anticlinal of Peaked Mountain has not entirely subsided on the cross section at Heckscherville.

From the North and South Tunnel, already described, cutting all the strata from the Church down to the Daniel seam, the Crosby and Daniel coal-beds are mined 2000 yards W. At the end or face of the gangway the Daniel Coal measures 15 feet in thickness, including a band of slate 2 feet thick ranging through the bed 8 feet from the bottom: above this slate the coal is often dirty and impure. The slate is not always present.

The Crosby Seam is very faulty W., but little coal is now taken from it. The "New Vein" is a double bed, having 6 feet of coal overlaid by 4 feet of slate, which in turn supports 4 feet of coal. The gangway upon it is a fourth of a mile long. The Church Seam is 12 feet thick where it was struck by the tunnel; but 50 feet E. it is only 3 feet thick at the floor of the gangway, and two dips appear in the bed. Near the cross-cut to the shaft there is but little coal in the seam; the entire thickness is replaced by slaty coal and slate.

For facility in gaining access to the mine, a slope is established on the Crosby Seam, about 125 yards W.

of the old slope. Seventy yards W. of the New Slope from the Crosby Seam gangway, a tunnel is cut S. to the New Vein, and N. to the Jugular Seam. The strata cut in this tunnel, with the intervals between the coals, agree almost precisely with those at the water-level tunnel (Paine's), except in the measures between the Jugular and the big overlying Dirt-bed. This bed is greatly expanded; but the rock beneath is proportionally diminished in thickness. The Jugular Seam is 24 feet thick at the end of the tunnel. It is but newly opened to mining at this level, and no coal has been taken from it. Shipments, in 1857: from Old Breaker, six weeks' work, 5049 tons; from New Breaker, nine and a half months' work, 61,538 tons. Estimate aggregate capacity for 1858, 140,000 tons.

Pumping Engine.—Allusion is made in the foregoing description of the Heckscherville Colliery to the powerful pumping-engine designed to lift the water from this and such of the neighbouring mines as may communicate with it. We append a more precise description, furnished by Mr Harrison, who supervised its construction in the shop of George W. Snyder, of Pottsville.

The steam-cylinder stands vertically upon its bed-plate, which rests on massive stone abutments. The diameter is 50 inches, and stroke of piston 10 feet. The action is direct upon two pumps, each 20 inches in diameter and 10 feet in the stroke. The delivery-pipes are each 100 feet high, and 20 inches in diameter, lined with wood, and supplied with valves of a kind of bell-metal, which will resist the corrosive waters of the mine. The entire weight of metal in the structure is said to be 160 tons.

Three smaller engines of a similar description are at work in the coal region; one at Thomaston Shaft, another at Monterey (Graham's) Shaft, and the third at the Otto Shaft.

Taylor and Volpert's Colliery—situated on the N. Side of Mine Hill, 1 mile W. and 185 feet above the water-level of West Branch Gap.—A tunnel enters S. into Mine Hill, 43 yards to the Daniel or Mammoth Seam, upon which a gangway is wrought 760 yards. W. of the tunnel 340 yards, a tunnel is driven 20 yards S. to a small seam under the Daniel. It is not pure, and is worked but little. In the main gangway at this tunnel an engine was placed, and a slope sunk 100 yards; from this, gangways are driven 220 yards E. and 180 yards W. The accidental ignition of the coal in the mine by fire from the boilers, has caused the abandonment of this portion of the mine.

A new slope, 100 yards long, is now being sunk at the back end of this main tunnel. In this mine the Daniel Seam is from 7 to 8 feet in thickness, except in one part of the W. gangway, where it is thicker.

The shipments, in 1857, amounted to 12,596 tons.

Thomaston Colliery (page 207 of text)—R. Heckscher & Co. (Forest Imperial Company's Lands).—The Thomaston Tunnel is situated 150 feet above the level of Mine Hill Gap, and 760 yards W. of Taylor and Volpert's. It enters from the surface about 20 yards S. of the crop of the Crosby Seam, and from the mouth timber is driven 122 yards S. to the Daniel Seam dipping 38° S. The Lelar, dipping 51° S., is passed in the tunnel 88 yards N. of the Daniel. The latter bed is wrought 2200 yards W.; the dip augments W. to 46°. Two short tunnels are cut S. from the gangway of the Daniel to a small underlying seam, which is worked about 800 yards.

The thickness of the Daniel Seam varies between 8 and 15 feet. It yields from 5 to 10 feet of marketable coal.

North of the tunnel mouth, 213 feet, a vertical shaft is sunk 230 feet to the Crosby Seam dipping 47° N. Upon this seam gangways are opened 160 yards E. and 370 yards W. The breasts on the coal are 100 yards long. The Crosby Seam is 13 feet thick: thus far it has proved rather shelly and impure.

The shipments from the Thomaston Colliery, in 1857, amounted to 41,443 tons, working eleven months. Capacity for 1858 estimated at 75,000 tons.

From the above reliable facts concerning the Thomaston Tunnel, it will at once appear how greatly we were misinformed in our notes upon the same colliery, printed on page 207 of the text. The distance to which the Daniel Seam has been mined W. of the Tunnel destroys the probability of the once prevailing conviction, expressed on page 211, of the shallowness of the S.W. Branch of the Mine Hill Basin.

Glen Carbon Colliery (page 208 of text)—Lessees, M'Farland and Werner.—We have already presented,

on page 208, some account of this colliery, procured in 1852; we have now more accurate data, derived from mine surveys obligingly furnished by Mr C. M. Hill.

A tunnel 200 feet long enters N. into the Broad Mountain to the "Dirt Vein," or a mixture of coal and slate, corresponding in position to the Lelar or Slope Vein of Heckscherville. This was followed 200 feet W., and the South-dipping strata lying beneath are passed through by a tunnel 196 feet long to the "North Vein," which is to be regarded as a subdivision of the Daniel. In this tunnel several coals were cut as follows, with the intervals:—From the "Dirt Vein," 62 feet to a coal 2 feet thick, S. dip 38°; 60 feet to a coal 2 feet 8 inches thick; and 33 feet to the Daniel or Mammoth Bed, of which the thickness averages about 9 feet, including two thin seams of slate. This bed dips 45° S. at the tunnel, but steepens W. to 70°. The North Bed contains 5 feet of hard coal: it dips 42° S., steepening W. to 52°. At the tunnel this seam is separated from the Daniel by 40 feet of strata. In the gangway upon the latter, 3600 feet W. of the tunnel, this thickness has dwindled to 2 feet, and the two seams have been mined together. The gangway upon the Daniel Bed is 4000 feet long.

The gangway upon the North Coal is driven W. 1250 feet to a third tunnel cut N. 273 feet, through four small beds corresponding with those in Heckscherville Tunnel, to the top of the "Tumbling Vein," dipping S. 40°, from which it is 85 feet to the top of the underlying "Jugular Vein." The latter seam is in confusion at the end of the tunnel, owing apparently to the conflicting dips of a small saddle and basin which appear to end at this point. At its crop above the tunnel, the Jugular Seam has resumed its natural condition, and dips about 45° S.

The "Crosby Vein," lying 250 feet S. of the Daniel, is entered by a tunnel crossing the strata obliquely from the "Dirt Vein," and is mined W. 3500 feet, when it is pinched out. Upon this seam a slope was recently sunk 80 yards below the tunnel-level on the bottom slate, dip 55° at top, and 62° at bottom, and gangways are now working from this slope 500 yards W. and 160 yards E. The Daniel Bed is also cut on this lower level in a tunnel driven back 78 yards to it from the gangway, 35 yards W. of the slope. At the same distance E. of the slope a tunnel is cut 23 yards S. to a coal-seam 3 feet thick: it is not wrought. The Crosby is here developed as a fine bed of coal, ranging from 16 to 20 feet in thickness: a slate sometimes appears under the top bench, but it is otherwise quite free from impurities.

This colliery yielded, in 1856, 19,249 tons; in 1857, 20,908 tons.

Peaked Mountain Colliery (page 208 of text)—Lessees, Steel and Patterson (formerly Oliver).—A shaft is sunk 81 feet, from the bottom of which a tunnel is driven S. under the Peaked Mountain. It cuts four seams of coal at intervals, as follows:—52 feet to 11 feet bed, N. dip 50°; 149 feet to 12 feet coal-dirt and coal, N. dip 51°; 147 feet to Crosby Vein, 11 feet thick, N. dip 53°; and 360 feet to the Daniel Bed, 13 feet thick. Gangways are worked E. and W. upon each of these seams. The E. gangway upon the Daniel Bed deflects S. around the declining arch of the Peaked Mountain anticlinal; the breasts from the gangway level extend to the crest of the saddle over which the coal arches into a S. dip. The old water-level tunnel leading S. to the Crosby Vein is now abandoned. The shaft is to be extended downward 228 feet, to secure another breast upon the coal.

Yield of this mine, in 1856, 28,745 tons; in 1857, 29,410 tons.

J. F. Taylor's Colliery (formerly Taylor and Atwood's)—half a mile E. of Monterey, head-waters of West Branch.—Two water-level gangways or drifts have been pursued W. somewhat over a fourth of a mile. The seams wrought are not positively identified; one of them is in all probability the Daniel, the other the Crosby. Dip in both cases from 45° to 53° S.

On the S. Drift Coal or Crosby (?) Seam a slope was recently sunk 83 yards below water-level on a dip of 48° S. This bed is stated to be 8 feet 6 inches thick. The Daniel, a slaty and bony bed, is 9 feet thick.

This colliery shipped no coal in 1857.

Schollenberger's Glendower Colliery (situated on the N. Side of Peaked Mountain, S.E. of Taylor's).—At water-level, a tunnel driven Southward 37 yards penetrates the Crosby Seam, dipping 45° or 50° N. The gangway is driven 650 yards Westward. Breasts from 25 to 30 yards long.

Monterey Colliery—Agent, H. H. Dunn (formerly J. S. Graham).—This colliery is situated near the W. end of the coal-basin, which ranges at the S. base of the Broad Mountain. A slope is sunk on the N. side

of the basin upon a seam which corresponds in position to the "New Vein" of Heckscherville. Length of slope, 65 yards; dip, 62°. The gangway E. is driven 600 yards, and that W. 500 yards. In the latter direction the gangway deflects Southward round the rising basin of the coal. The bed is 10 feet thick.

From the foot of the slope a tunnel runs 45 yards S. to the Church Seam, 5 or 6 feet thick. The gangway is driven 50 yards E. and 100 yards W.; but the coal proves shelly and poor. A tunnel, 50 yards long, is driven N. from the gangway 5 yards E. of the slope to the Crosby Seam. This coal is 14 feet thick, and free from slate. Gangway, 600 yards E., and the same distance W. This gangway also is affected by the rising basin. Dip at end of basin 10° E. At this point the coal is somewhat shelly and crushed. The breasts are upwards of 200 yards long. From the Crosby Seam, 60 yards E. of the entering tunnel, a tunnel is driven 87 yards N., passing three very small seams to the Daniel Bed, which is characterised by the same finely-laminated slate which overlies the bed at Heckscherville, and elsewhere to the Eastward. The seam is 8 feet thick, including 7 feet of coal. The gangway E. upon it is 60 yards long.

Shipments of coal in 1857, 27,570 tons.

Greenwood Colliery (Reed Improvement Lands)—situated on the S. Side of Peaked Mountain, S.W. of Schollenberger's.—A tunnel, at water-level, is driven N. 37 yards to a coal-seam dipping 45° S. The subdivisions of the bed are as follows:—

Bone Coal and Slate, 4 to 10 inches; Coal, 1 foot 6 inches to 2 feet; Coal, 4 feet 6 inches to 5 feet; Coal and Slate, 1 foot 6 inches to 3 feet.

The tunnel, prolonged, cuts through a seam 4 feet thick, separated from the preceding by 6 feet of slate, and, passing a leader 65 yards from the mine-mouth, is extended to a seam of rough coal 80 yards from the entrance. The last coal dips 37° S. The gangway on the main coal is driven 170 yards E. and 540 yards W. The dip declines Westward to 35°. We have no data guiding us to a certain determination of the equivalency of this seam, or whether it is higher in the strata, and how much higher, than that wrought at Rohrer's Colliery farther W. The tunnel is now being prolonged, in the expectation of cutting lower valuable seams.

No coal shipped in 1857.

W. Rohrer's Colliery (page 209 of text)—situated at the W. End of Peaked Mountain.—A slope is sunk 110 yards below water-level on a seam of coal dipping S. 40° at the outcrop, and 70° at the foot of the slope. The exact position of the bed in the series, and its equivalent elsewhere, has not been determined, but it is evidently quite low. The usual subdivisions of the bed are stated as follows:—

Coal, 3 feet; Slate, 1 foot; Coal, 5 feet; Slate and dirt, 10 inches; Coal, 3 feet; Slate, 1 foot 6 inches; Coal, rough, 4 feet.

From the slope a gangway is driven 400 yards Eastward; at the face the dip is 30° S., and the breast, to water-level, upwards of 140 yards. A roll in the coal causes an E. dip, along which an old water-level gangway sweeps N. for some distance, but has not affected the lower level.

The gangway driven 50 yards W. struck the basin of the coal rising Westward. Higher on the breast a counter-level is driven on a small anticlinal roll, which seems to expire Eastward, as it was not discovered in the slope. The rising of the basin alluded to causes the gangway to swing round into a N. dip, which, 40 yards E., changes to E. dip, and finally into S. This saddle thus developed, expiring Eastward, affects the gangway in the usual manner; the joint result of the rising basin and drooping saddle being a sigmoid curvature of the gangway. Ranging Westward, the anticlinal must pass along the S. side of Buck Ridge, but it has not been traced. On its flank the coal in the gangway is finally cut out, except the lower bench, which is nowhere of sufficiently good quality to be profitably mined, and the level is abandoned. We have no information of the distance to which it was driven before this fault appeared.

In 1857, 15,098 tons were shipped from the mine.

BOOK VIII.—*Continued.*

BROAD-TOP COAL-FIELD.

The next district which claims our attention, in a systematic description of the coal-fields of Pennsylvania, is the Broad-Top Mountain in Huntingdon and Bedford counties. The general structural features of this insulated table-land have been already noticed in Chapter I. of Division III. of Book VI., and again in Chapter V. of Division IV. of Book VI., where mention has also been made of its Vespertine and Umbral rocks, or its Lower and Middle Carboniferous formations. I have already shown, at Page 361, Vol. I., that this outlying coal-field occupies a midway position in the mountain-chain, in the same long synclinal belt which in the North-eastern corner of the State embraces the third or Northern Anthracite Basin. While its geographical relations link it thus with the Anthracite coal-fields, its geological analogies, especially the chemical composition of its coal, associate it rather with the great Bituminous Coal-region N.W. of the Alleghany Mountain, of which we may regard it as an outlier, as indeed we must, in strict sense, the Anthracite Basins themselves. Considerations of convenience induce me to describe this district in Book VIII., notwithstanding that all the coal included in it belongs to the semi-bituminous variety. Such an arrangement is justifiable even on strictly geological grounds; for as the Coal-measures of the Broad-Top Mountain, and the coal itself, are intermediate in type between those of the Anthracite and those of the Bituminous coal regions, they should occupy an intermediate place in any methodical account of the formation. Their deviation from the Bituminous Coal-measures is due to the same causes which have made the strata of the Anthracite fields to depart still more widely, namely, the same originally greater amount of shore action, and the same subsequently-exercised metamorphic agency, altering or de-bituminising the coal of the whole mountain-zone. Classified in accordance with the chemical nature of its coal, this coal-field relates itself quite as closely to the Eastern Anthracite basins as to the Western Bituminous ones. In the description it was shown that the coal of the Western extremities of the Southern and Middle Anthracite fields graduates from Anthracite into a dry semi-bituminous coal as we approach the Susquehanna, so that even there there is an approximation to the composition typical of the Broad-Top Field. In general terms, the proportion of volatile matter in this insulated coal-field does not exceed by more than a few per cent that of the coal in the Western end of the Dauphin Basin, while it falls short by a rather larger ratio that of the basins next W. of the Alleghany Mountain.

Boundaries of the Broad-Top Coal-field.—The detached coal-basin of the Broad-Top Mountain is situated centrally in the long synclinal trough of the Older and Middle Carboniferous Formations of the Fourth Belt of the Sixth District, described at page 528, Vol. I. The plateau of the productive coal-rocks is everywhere margined by the Seral Conglomerate, itself merely an underlying comparatively barren division of the Coal-measures. To the N. of this plateau lies Plank Cabin Valley, scooped in the softer Umbral Red Shale ; to the W. of it stretches

a deep narrow valley cut in the same formation, and bounded Westward by Terrace Mountain; to the Eastward is a similar narrow valley bounded Eastward by Sideling Hill; and to the S. a more irregular Red-shale valley, confined by Harbour Mountain, and called Well's Valley. Into Plank Cabin Valley and Well's Valley the Broad-Top Mountain projects a series of synclinal knobs or finger-like spurs, each of them marking the termination of a subordinate trough, or a sub-basin of the Coal-measures.

Area of Coal.—It is not practicable in the present imperfectly developed state of this Coal-field to estimate the area of its Coal-measures with exactness. My calculations indicate about 25 square miles.

Let us now proceed to a detailed description of the structure and contents of the Coal-field.*

The Seral Conglomerate in the Broad-Top Coal-field is to be regarded simply as the oldest or lowest of the sandstones of the Coal-measures. It is imperfectly exposed for measurement at the S. side. Beneath Savage's or Norris's Coal-bed, on Rocky Ridge, and Stambaugh's in North Wray's Hill, it would appear to be less than 150 feet in thickness. It is finely exposed for 50 feet above the alternating sandstones and shales of the Umbral and Seral strata in the Raven Rocks, 2½ miles S. of De Forrest's, at the gorge of Trough Creek. At this point hard and massive coarse-grained grey and greyish-white beds, tinged greenish, buff and brown, and from 2 to 4 feet thick, alternate with thin-bedded grey and brownish beds of sandstone, with a few seams of black shale full of vegetable impressions.

The upper members of the Seral Conglomerate are well exposed on Rocky Ridge at Savage's and Taylor's old openings on the lowest coal. Here a characteristic stratum, usually the floor of this coal-bed, a fine-grained massive sandstone, sparkling with mica, dips 30° S. 70° E. This rock is traceable by its angular fragments on the sides of Rocky Ridge, and on the opposite summit 1½ miles S. of Savage's, dipping 35° W. Beneath it is found a coarse brown micaceous obliquely-bedded sandstone 7 feet thick, reposing on massive white sandstone, made up of granules of milky quartz. Farther S. it becomes a fine white conglomerate. The same stratum appears on Round Top, near the Trough Creek Furnace, but not on the higher summit of Round Knob, near McLean's.

Fig. 314.—Topographical Sketch, Shirley's Knob, Broad-Top Mountain.

North Wray's Hill, at first a succession of short low knobs, along the E. side of Shirley's Knob and Rocky Ridge, becomes a ridge 3 miles S. of Cassville. It increases in height and breadth of summit S., and exhibits two crests, the Easternmost of which is cut by a deep wide gap, and is traversed by a feeble anticlinal roll, which flattens away at Deever's. The W. summit widens rapidly, and is soon capped by the undulating strata of the Seral conglomerate, over the surface of which spread the "Barrens." It is upon these that the lowest coal-bed—that opened by Stambaugh—appears. The conglomerate, estimating its thickness from the dip, cannot exceed 150

* Many of the observations embodied in this description were made prior to the year 1845, but the text then prepared for publication has been recently re-written, with numerous corrections and additions, after a careful study of the whole ground, as lately as 1857.

feet; nor does it exhibit a massive or conglomeritic aspect in all places. In the ravine between the two summits of Wray's Hill, massive fragments of fine white-grained conglomeritic sandstone are abundant. Three and a half miles S. of Stambaugh's openings upon the level surface of the hill, McLean's Coal-bed lies closely upon the conglomerate, and is capped by a knoll or dome-shaped hill of sandstone.

The E. brow of Wray's Hill is begirt with cliffs of conglomeritic white sandstone from 30 to 50 feet in height. The floor of Well's Valley below is strewn with fragments of heavy conglomerate, the pebbles of which are as large as the egg of a goose. Although these blocks have doubtless come from some of the neighbouring summits, the rock from which they were derived was not found in place.

Returning now to the N. margin of the high land, we find six spurs projecting N. into Plank Cabin Valley. Each of these contains a shallow synclinal basin ranging S. into the Broad-Top plateau. A careful examination of these basins has led to the conclusion, that even the lowest coal-bed has been swept from all of them, except the second or that called Rocky Ridge, in which it has been preserved from denudation for half a mile to the N. of Savage's openings; but it certainly does not reach Trough Creek Gap, nor reappear on Shirley's Knob. Shirley's Knob is a monoclinal ridge of West-dipping rocks, belonging to a basin of which the W. side has been swept away. The highest stratum is a conglomerate, dipping 55° W. It therefore contains no coal. For a like reason no coal is thought to exist on the Round Knob, the Grave Mountain, the two W. spurs of the Broad Top, nor on the hill called Round Top.

The width of the synclinal basin of Rocky Ridge, from the E. to the W. outcrop of the sandstone stratum which supports the lowest coal-bed at Savage's old mines, is not more than 400 yards. The dip on the E. side of the basin is 60° N. 60° W. Opposite Taylor's mines, one and a half miles further S.W., the synclinal of the coal is broader, and the dips gentler, but the W. dip still remains the steeper of the two. A short distance N. of the Raven Rocks, where Rocky Ridge is broken off from the Broad-Top plateau, the breadth of the basin is about 300 yards; but the W. dip is almost horizontal, and the E. dip as steep as 50°. This change is owing to denudation, which has cut away the E. side of the basin nearly to its centre. The coal may be opened anywhere along the ridge on both outcrops, but is probably of impaired quality, except where the dips are at a high angle.

Savage's openings are adjacent to the W. summit of Rocky Ridge, about three-fourths of a mile S.W. of the gap occupied by Trough Creek. The coal at the mine dips sometimes S., though more frequently S. 25° E., at an average angle of 12° or 14°. It is about 4 feet thick, of excellent quality, and convertible into a good coke. Numerous obliquely transverse joints divide it into rhomboidal fragments. The seam is overlaid, and also supported, by solid layers of dark fine clay, each about six inches thick, which, by exposure, are converted into a plastic clay. Above the coal are 40 feet of dark slate, with a few bands of sandstone. A compact shale, used for whetstones, is also found, both above and below the coal. Soft yellow iron-ore, with layers of a hard chestnut brown variety, is found deposited around the Spa Spring near Savage's.

Taylor's openings are said to have yielded 4 feet of coal. Loose masses of a lean ore are found on the surface near by. The synclinal basin of Wray's Hill has a width, between the two summits, of 700 yards, from a point a little N. of Stambaugh's openings. The E. dips are 30°, and the W. dip 25° or more. Within this basin observations upon the Seral conglomerate lead

to the inference that one, if not two, gentle anticlinal elevations exist. Coal-openings have been made across this shallow basin ; but the bed, although about 6 feet thick, has too light a covering of rock to be hard and good : it is undoubtedly the lowest bed of the series. M^c^Lean's opening is said to have yielded 4 feet of light and very inflammable coal. The bed is divided by 3 inches of slate. Its outcrop is traceable all round the base of the knoll which rises from the barren plain, here more than a mile in breadth. The coal rests on slate, and its roof is sandstone. The platform of the Barrens seems to be a grey conglomerate, probably the upper bed of the Seral conglomerate.

A very gentle descent for two miles, from M^c^Lean's, leads W. down into the valley of Trough Creek, and to Alloway's or Houck's old opening upon its W. bank, near the Fort Littleton Road. The coal, which dips 6° N. 60° E. averages 4 feet in thickness, one foot of which, in the middle is black slate. It is overlaid by slate. The bed contains more sulphuret of iron, and is more slaty, than that at Savage's, with which, and M^c^Lean's, it is probably identical. The same fine-grained cherty-looking stratum, 3 feet thick, observed above Savage's coal, is seen above Alloway's Bed.

At the S. end of this basin, on the head-waters of Trough Creek, are Ludwig Fisher's openings upon a bed 2½ feet thick, capped by slate passing into sandstone 4 feet thick, above which, at the surface, is another coal-bed 2 feet thick. About one mile E. of this, and high on Wray's Hill, a coal has been opened by Mr Edwards. This bed is said to be 5 feet thick, including a band of slate 8 or 10 inches thick, 18 inches from the bottom. The dip is Westward.

For want of a detailed map we are unable to trace S., across the rolling plateau of the Broad Top, the anticlinal axis, with gentle dips, which separates the N. extremities of the Third and Fourth basins, or Round Knob and Grave Mountain ; nor can we follow the anticlinal that separates the Fifth and Sixth basins. Judging, however, from the gentle S.W. descent of the alternating strata at the head of Plank Cabin Valley, there would appear to be a general S.W. subsidence of the undulations towards the centre of the coal-field. The direction established for these and the main flexures of the region is S. 30° or 35° W.

In the N. portion of the plateau coal-openings are rare and unpromising.

The Umbral shale appears in the fields of H. Haupt. It outcrops around Grave Mountain. At Mr Diggens', fragments of Seral conglomerate appear ; and at H. Horton's, Coal-measures overlie the conglomerate. An imperfect opening revealed 2 feet of coal dipping 15° N. 60° W., 300 yards W. of which there are outcrops of hard grey and softer white sandstone, dipping 20° N. 60° W., and a little beyond this the dip is 10° S. 60° E., showing the middle line of the synclinal basin. From this to H. Millar's, the rocks undulate or lie horizontally, and but few exposures are to be seen. In this interval coal crops out at H. Haupt's. Mr Millar's fields contain olive and green shales ; and near his house there are fine exposures of massive Seral sandstone.

The bold bluff of massive white conglomeritic sandstone, from 10 to 15 feet high, W. of Millar's house, and dipping 10° S. 40° E., is probably the Seral conglomerate stratum. Below this occurs a lesser bluff of fine white sandstone, not so massive as the former. Scarcely 50 yards horizontally from the upper bluff a coal has been opened on a cleared slope, but it is only 6 inches thick at the opening.

An anticlinal flexure runs up the deep ravine between Mr H. Millar's and Corcillin's, on the W. side of which two coal-beds have been opened : the lowermost, with a poor covering, proved 2 or 3 feet thick. Above it is a bluff of Seral conglomerate, and 400 yards horizontally W. of it a higher coal 3 feet thick, but without proper cover or any breast for mining.

Passing farther to the S. we enter upon the ravine of Shoup's Run. This is a deeply-cut gorge, the general course of which traverses the coal strata, nearly at right angles, from the new village of Broad-Top City to the vicinity of Coalmont. It has afforded favourable opportunities for mining coal, and many mines are situated upon its borders. We shall detail the observations made upon these as they were followed up the stream from Coalmont E. towards Broad-Top City.

The first appearance of the Seral conglomerate, at the level of Shoup's Run, is about one-third of a mile above the village of Coalmont. Rising above the bed of the valley at an angle of 50° upon a S.E. dip, it forms, in Raven Hollow, which comes in from the S., a conspicuous ledge of rocks 20 feet high, representing the lower member. At this point the dip is about 45°, but the rock is intersected by numerous parallel joints, which almost obscure the less distinctly marked plane of bedding. These joints dip S. 75° E. at the high angle of 80°. The rock, when freshly broken, appears to be a pinkish-white very compact sandstone, weathering grey, and is not at all conglomeritic. A little above this ledge, and constituting the upper member of this Seral conglomerate, is a pure white fine-grained sandstone, which is exceedingly uniform in its bedding and splits into beautiful flags suitable for building purposes.

Within 100 feet of the Seral conglomerate on Shoup's Run, occurs Mr Schell's Opening upon the lowest coal. The dip of the bed at the mine-entrance is 20°, but it rises to 30° as the gangway advances S. The subdivisions of the coal are as follows :—

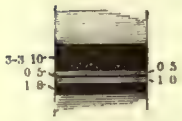


Fig. 315.—Schell's Coal.

Coal, from 3 feet to 3 feet 10 inches ; Slate, 5 inches ; Coal, 5 inches ; Slate, 1 foot ; Coal, 1 foot 8 inches.

This bed is known as Barnett's, from the old mine of Philip Barnett higher up the stream, and we shall hereafter designate this lowest workable seam by that title. Within 50 feet E. of Schell's Opening the coal basins and rises out to the surface upon a W. dip of 20° near the lowest house of the mining village. It then arches in a broad low anticlinal, and after forming a shallow basin again rises on a W. dip of 18° at the mines of the Broad-Top Railroad Company, leased to Mr A. Patrick. At these mines the coal has a total thickness of 4 feet 3 or 4 inches. On the N. side of the run, opposite Minersville, the same coal-bed is mined from four openings upon a breast which rises E., with several slight undulations, at an average angle of 15° or 18°, until it crops out on the flank of the great anticlinal which ranges across the valley between Minersville and Barnettstown. The latter mines are wrought by Powell & Saxton, as lessees of the Railroad Company. The Barnett Bed is the only one which has been opened on Shoup's Run in the general basin between the W. cropping of the Coal-measures and the anticlinal above mentioned.

This great anticlinal which crosses the run just W. of Barnettstown, and within a few hundred yards of the mines above alluded to, brings the lowermost beds of the Seral conglomerate to the water-level. It has the effect of throwing off the Coal-measures upon its flanks to form two lines of outcrop. The anticlinal ranging S. is believed to pass E. of Mr Osbourn's house and Horton's sawmill to cross Six-mile Run, and run through the hollow of Trough Spring Creek to Sandy Run, above its confluence with Long Run. On Shoup's Run the rocks at the anticlinal dip W. 20° and E. 25°.

The first mine upon the E. side of the axis is Patrick's Upper Mine, where the Barnett Coal is wrought. The coal itself is rather soft, and somewhat thinner than usual. Between this opening and the anticlinal there seems to be some disturbance in the strata, by which Patrick's Coal is sharply turned down from the outcrop to be again found near the Railroad level. The

openings did not admit of examination, and we are ignorant of the true nature of the difficulty. The lower coal is quite faulty and worthless. On the opposite or E. side of the Run, which is here flowing N., occurs the mine of Messrs Orbison and Dorris, and near it is the old drift of Philip Barnett upon the same bed. The dip of the coal is quite gentle; its thickness is as follows :—

FIG. 316.—Orbison's (Barnett) Coal.

Coal, of excellent quality, 2 feet 10 inches; Slate, from 3 to 5 inches; Coal, 1 foot.

The bottom slate is pyritous and compact, the top rock is a compact olive shale, with interstratified layers of fine grey sandstone. The gangway upon the coal at the Orbison and Dorris Mine had penetrated 200 yards at the date of our visit (October 1857).

FIG. 317.—Philip Barnett's.

But a few hundred yards above this mine the coal basins at a depth of 45 feet beneath water-level. This was proved by a shaft sunk to coal, which was found dipping N.W. 3°. It was further proved by Mr Blair, who has driven a tunnel from the water-level to meet the coal as it rises to the surface. It was found about 100 yards from the point at which the tunnel entered. In these explorations a small seam of coal was encountered lying 10 feet above the Barnett Bed. On the hill-side opposite Blair's, and a little higher up the stream, is an old opening by Orbison and Dorris, on the same bed, dipping gently W.; and near the high trestling of the railroad is Noble's old drift mine. In the bed of the creek, and about 35 feet below the Barnett Bed, are seen two small seams of coal, separated by 4 feet of strata, and measuring respectively 4 and 6 inches. In the slates adjacent to these are found impressions of plants, and in the shales above thin bands of carbonate of iron. These thin coals lie close to the Seral conglomerate, which rises to the water-level, on a gentle anticlinal roll, about 150 yards farther E. This anticlinal has not been traced by us through the rugged country lying to the N. and S. of Shoup's Run, but it doubtless has an important influence upon the distribution of the strata.

We now enter upon a wide shallow basin, bounded on the W. by the anticlinal just mentioned, and on the E. by another ranging through the main plateau of the Broad Top at the head of the ravine of Shoup's Run, near Broad-Top City. As the conglomerate arches the former of these at the creek level, the Barnett Seam must soon re-enter the hills, but it has nowhere been opened. All the explorations hitherto made have been confined to the hill-sides, at some distance above the bed of the ravine, and they develop only higher coals. To these we shall now refer.

From three-fourths of a mile to a mile above or E. of the high trestling of the railroad, and a less distance from the anticlinal, are several openings upon two beds of coal, dipping E., usually separated by about 30 feet of strata, which occupy a position intermediate between the Barnett Bed and the next higher large bed, known as Cook's. The upper of these measures 3 feet, and is underlaid by bluish-grey argillaceous shale. The capping-rock is sandstone. The lower coal is 2 feet thick. At a higher level in the strata is the Cook Bed, wrought by the Broad-Top Improvement Company, at several points, upon a S.W. dip. At the lower mine three gangways enter the coal at different levels on the breast which inclines at an angle of about 3°; in one of these the following measurements were obtained :—

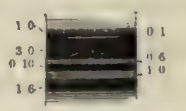


FIG. 318.- Broad-Top Improvement Company's Coal.

Coal, 1 foot; Slate, not always present, 1 inch; Coal, 3 feet; Slate, known as the mid-rock, 6 inches; Coal, 8 or 10 inches; Slate (average 6 inches), 1 foot; Coal, 1 foot 4 to 6 inches.

As the coal rises at a very gentle inclination, it is opened at several points near the Railroad, which ends at the upper mines of the Broad-Top Improvement Company, near the Old Cook opening, within half a mile of Broad-Top City. In these drifts great local variations are found in the thickness of the dividing-slates. In the mine of Messrs Keeley and Cunningham the lower slate has thickened to 4 feet, and the 16-inch band of coal is found beneath it. At another point where the coal is entered by a plane or breasting up the dip, the mid-rock or upper slate measures 15 inches. In one part of the Improvement Company's upper mine, the same slate is 3½ feet thick, but it does not average so much. In Jesse Cook's old mine, opposite the latter, the following are the subdivisions of the bed :—

Coal, 10 inches ; Slate, 3 inches ; Coal, 2 feet ; Slate, (upper member sometimes a sandstone), 1 foot 4 to 8 inches ; Coal, 5 inches ; Slate, 4 inches ; Coal, slaty and sulphurous, 1 foot 2 inches.

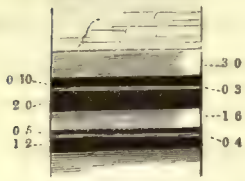


Fig. 319-320.—Cook's Coal.

The bed dips 6° S. 60° W. It is overlaid by 3 feet of slate which supports a dark-grey sandstone containing fossil impressions. There are indications of a thin band of coaly matter in these measures, 20 feet above the Cook Bed.

Near the road-side, and 200 yards S.E. of Jesse Cook's Mine, there is an opening upon a coal-bed, estimated to overlie the Cook Seam about 60 feet. It measures 3 feet, including a band of slate 1 inch thick, and 10 inches from the bottom. It occupies a position not far beneath the big sandstone stratum which supports the table-land of Broad-Top City. The same bed of coal occupying a corresponding position beneath the somewhat pebbly sandstone known as the "Big Rock," has been opened and drifted into upon the hill-side, a few hundred yards S.W. of the lower mines of the Broad-Top Improvement Company.

S. of the parallel of Shoup's Run, the Broad Top is intersected by other deep ravines, down which flow the waters of Six-mile Run, and the tributary branches of Castillo's Run, known as Sandy and Long Runs. At the extreme S.W. edge of the Broad Top is Kimber's Run, flowing into the Raystown Branch of the Juniata, 2 miles above Hopewell, at the mouth of Castillo's Run. In the interval between Shoup's and Six-mile runs, which flow at an average distance of 3½ or 4 miles from each other, rise the elevated summits of Barnett's Hill and Anderson's Knob. To the S. of the latter, and between it and Long's Run, lies Round Knob, and in range with it and Anderson's Knob occurs Swartz's Ridge, lying between Long and Sandy runs. This range of hills contains, on account of their structure and their height, the greatest residual thickness of Coal-measures. To the Westward the general plateau of the Broad Top exhibits a high irregularly undulating surface, which is quite covered with forest. As, however, the explorations for coal have been confined chiefly to favourable localities in the valleys below, and as the useful rock-exposures are few and isolated, the details of structure in this complicated district are still very obscure. As we lacked the invaluable guide of a good topographical map upon which to connect the exposures which exist, we were obliged to restrict ourselves principally to careful examinations in the transverse valleys, where we were aided by natural developments and the progress of mining.

On the Western slope of Barnett's Hill, upon the road from Coalmont to Fort Littleton, and a quarter of a mile from the former place, the Seral conglomerate or sandstone is exposed, dipping E. of S., at an angle of 15°. At a lower level Red shale crops out; and about 50 feet above the uppermost exposure of the sandstone, Mr Evans has opened the Barnett Coal-seam. The coal is

much crushed, and is very irregular in thickness, varying from 4 feet to 6 feet, and even more. Its dip also is fluctuating both in direction and degree. Some distance higher on the hill, and more to the S., a bed apparently much higher in the series has been opened at various points in the vicinity of Mr Donaldson's house, upon the lands of Mr Schell. The gangways upon it were closed, and the thickness of the bed could not be measured ; but this is said to be considerable. Farther S. a drift was entered upon a coal, which at the outcrop measured 1 foot, and contrary to expectation the coal dwindled away as the gangway advanced. In the shales beneath this coal, balls of white carbonate of iron, of good quality, are disseminated. Near the top of the hill, at Barnett's Sugar Camp, a fine bed of coal is opened. The bottom bench is 14 inches thick, the middle bench 2 feet 8 inches ; the upper bench is not visible, but the thickness of the entire bed, including slates, cannot be less than 5 feet. The dip at all of these localities is gently E.S.E.

An old opening known as Hamilton's, and a more recent one, Entriken's, occupy positions at the base of the hill, near Hamilton's, on Put's Branch of Shoup's Run, within a mile of Coalmont. It is impossible, without further research, and the use of instruments, to define precisely the relative positions of the several coal-beds in Barnett's Hill. There is, however, sufficient evidence to enable us to affirm that the Coal-measures exist in great thickness, and that probably many of the valuable beds of the region will be found in it.

In describing the traverse of Six-mile Run, and the other streams flowing Westward from the Broad Top, it will be expedient, for the sake of clearness, to follow them Eastward from the river towards their sources. We come now to treat of the stratification and structure of the coal region as developed on *Six-mile Run.*

Where the ravine of Six-mile Run opens to the river-valley, the W. ridge of the Broad Top presents a curious projection to the river. This may, perhaps, be accounted for by a slight double roll in the flank of the mountain. The same may be seen at Hopewell and elsewhere, along the W. escarpment of the plateau.

For the first half-mile ascending the Six-mile Run the strata are composed of Umbral red shale, alternating towards the top with the sandy beds of the Seral rocks. The first exhibition of coal is that of the Lancaster Coal Company at the Old Riddle Mine. The locality of this mine is one of evident confusion in the strata, and much doubt yet remains about the identity of the bed with those occupying the same apparent horizon. The coal at the old drift dips gently W. into the basin where the new mine enters it. It was found at first to be 5 feet thick, but swelled to 10, and even 12 feet, as the gangway was driven forward. The roof is quite regular, but the floor very uneven. In the new gangway great difficulty in mining has arisen from an upheaval of the coal transversely to the centre of the basin. This occurred in the gangway, 100 yards from the mouth. The floor was found upheaved to the height of 15 or 20 feet, carrying coal and roof with it, but leaving a trace of the coal along the plane of dislocation. The dislocation extended entirely across the basin, and the impediments to mining, at the date of our visit, had not been overcome, though it was thought they soon would be. The coal is hard, often polished and crushed, and is divided by no regular stratum of slate, but is interleaved with thin plates of slate which adhere very tenaciously to it. The lower part of the bed is considered the best. The roof is a blackish olive slate with pencil fracture, 4 feet thick, becoming grey and more silicious upwards for 15 feet, and covered by hard, dark-grey laminated sandstone. Other

massive, very hard, dark sandstones appear still higher in the series. Immediately beneath the coal there is a variable band of indurated fire-clay, containing balls of iron ore.

Thirty feet below the Riddle Coal appear beds of pale blue sandstone, weathering yellow and brown, from 6 to 12 inches thick, and perpendicularly jointed. They present a total thickness of 50 feet. Immediately beneath there is a crushed coal 2 feet thick, dipping E. at an inclination of 35°. Below this on the N. side of the gorge the Seral conglomerate is obscured by debris. On the S. side, upon the run, a mass of sandstone 20 feet thick rises from the water-level. This rock has all the characters of the Seral conglomerate of this region. It is a compact homogeneous heavily-bedded sandstone, traversed by parallel joints or cleavage-planes. The plane of bedding dips S. 80° E. at an angle of 45°. Beneath it appear nearly 150 feet of more flaggy sandstones, alternating in the lower part with red shale. Over it are visible 50 feet of blue argillaceous and sandy shales, including one or two thin bands of dark-blue slate; but no sign of the presence of coal can be detected.

If the massive sandstone really represents the upper stratum of the Seral conglomerate, we find it difficult to suppose that the 2-feet thick coal-bed above mentioned can represent a small seam usually found closely contiguous to the conglomerate, for the strike of the rock makes it appear fully 150 feet beneath that bed. The same difficulty forces us to regard the Riddle Coal as higher in the series than the Barnett Seam, to which it is generally regarded as equivalent. Any other supposition implies either an enormous thickening of the rocks between the latter bed and the conglomerate, or a transverse dislocation by which the strata on the N. side of the Run have been thrust E. several hundred feet.

Certain it is that the Riddle Coal-bed is, to all appearance, the lowest, with one exception, in the series. Some persons suppose a valuable bed to exist beneath it. Attempts were once made by Mr Hurl, of Huntingdon, to open such a bed upon the mountain, N. of Riddlesburg, and hardly 50 feet above the alternations of Seral and Umbral rocks. A bed 7 feet thick, it is commonly reported, was there discovered, dipping 40° S. 55° E. The floor is a greenish slate, underlaid by 3 feet of light-grey micaceous sandstone with coal impressions, reposing upon 10 feet of coarse grey ferruginous sandstone with quartz pebbles. Beneath this we find coarse granular light-grey hard sandstone 8 feet thick; fine-grained, greenish, thin-bedded sandstone 8 feet; interval 30 feet, and red shale surface debris downwards. Above the opening are seen slate and pebbly sandstone, overlaid by dark-grey sandstone. These exposures constitute a double line of cliffs along the mountain-side N.; the lower 30, the upper 25 feet high. A third ledge, 30 feet higher and near the summit, consists of rocks dipping 50° W., therefore forming with the latter a synclinal basin; but at the summit, rocks, which bear a close resemblance to those beneath the Riddle Bed, dip E. again. If these phenomena justify the opinion that a lower bed than any yet developed upon the Creek exists, and the true thickness be in any due proportion to its traditional size, it becomes important to discover it by careful research upon the Creek below the Riddle Mine.

The hill next E. of that which contains the outcrop of the coal-bed brings up the massive sandstone strata lying at the base of the Coal-measures upon a gentle anticlinal wave. The E. dip is 45°. These strata weather, in the upper portion, like the coarse and easily-disintegrated Meridian Sandstone of Warrior Ridge; the lower layers are harder and of a finer grain. The anticlinal has not been traced in its prolongation N. or S., though its magnitude would indicate

it to be one of the leading flexures of the W. division of the Broad-Top. Ranging S. towards Sandy Run it ascends Thornhill Run, passing W. of Lowrie's and to the N. is found between J. Griffith's and Osbourn's.

At Brandon's Point, ascending the Run, sandstone strata, like those on the stream below the Riddle Mine, dip 20° E., and 100 yards further E. nearly horizontal strata of slate 10 feet thick border the Creek, from the bed of which coal was once taken at the point where a retaining-wall now supports the roadway. The stratum was said to measure 18 inches in thickness; but upon reopening it, it was found to be 2 feet thick. It is overlaid by dark calcareous slate, abounding in fossil impressions. The slate descends gradually beneath the water and rises again as gently upon the E. side of the synclinal axis, outcropping in the bed of a lateral ravine which comes in from the S. about 30 feet above the flats. An opening has been made at an elevation of 60 feet above the outcrop of this slate, on the side ravine near Brandon's Point, and disclosed a coal smut 4 feet thick. This may be upon the outcrop of the Riddle Bed, as this seems to be its proper place. At the head of this ravine on the hill, 100 feet above the last-mentioned opening, a coal-bed has been entered by a drift for a short distance. The bed, including slates, measures 5 feet, of which from 3 to 4 feet is coal. The true place of these beds is still so involved in obscurity that it is impossible to define, with precision, their equivalents elsewhere.

The horizon of the Riddle Bed is obscured Eastward by undulations of the strata, and the few rock-exposures are unsatisfactory. The massive sandstones beneath that bed are nowhere seen as such above the water-level; and the presumption is, the bed is for the most part below it.

An anticlinal axis may be remarked between Figard's Mill and Fairplay, crossing the ravine of Six-mile Run. It appears along the deep ravine E. of Mr Osbourn's house, and passes W. of Horton's Sawmill. Sandstone rocks appear on its E. slope, dipping 25° E.; but on the W. we find slate, sandstone, and coal. The W. dip of 5° appears on the road from Osbourn's to Figard's Mill.

On the flank of this saddle a coal was struck in a well at Mr Osbourn's: it is 2 feet thick; and on Mr Lynn's farm further W., and a fourth of a mile from the brow of the Broad-Top Mountain, a bed has been opened dipping 10° W., and yielding, at the outcrop, 3 feet of coal; beneath the coal is shale 10 or 15 feet thick, and brown argillaceous sandstone. In the fields E. of Mr Lynn's house fragments of limestone appear. The rock has a grey ashy colour, smooth grain, and cherty aspect. The thickness of the bed has not been proved; but its presence shows that we are high in the series of the Coal-measures. The anticlinal passing Osbourn's ranges S. through Trough Spring Hollow to Sandy Run.

A few hundred feet S.E. of Horton's Sawmill a massive ledge of sandstone rises upon a gentle W. dip. The rock is in all respects similar to that lying at the base of the Coal-measures.

On the S. side of the Ravine of Six-mile Run, just above the opening of Trough Spring Hollow, there is a ledge of coarse grey sandstone, known as the "Saltpetre Rocks," which dips 25° or 30° N., 60° W. Further E., 120 yards, are the "Thunderstruck Rocks," a hill-side exposure of blue and grey slates, and grey sandstone, geologically above the Saltpetre Rocks, and dipping 45° in the same direction. Between the two exposures, a bed of coal has been opened 30 feet above the Creek. The ledge of the Saltpetre Rocks may be followed S. 100 yards to its

crossing of Trough Spring Creek. A short distance above, on the latter stream, the same rocks enter the ground upon a steep E. dip, and again form a basin, upon the gently-inclined W. side of which, a coal 28 inches thick has been opened. This coal has all the characters of the bed overlying that called the Cook Seam, at the head of Shoup's Run.

Returning now to Six-mile Run, we find, above the Thunderstruck Rock a few hundred yards, a curious wedge-like mass of coal, known as King's. At the surface of the hill-side the bottom of the coal has a gentle E. dip, and the top is very steeply inclined. Across the base of the wedge at the surface the bed is 15 feet thick, but it narrows down to about 5 feet at the point where the excavation terminated. Similar conditions, we are told, attended the outcrop of the coal opened between the Thunderstruck and Saltpetre rocks. In neither case did the mining penetrate far enough to develop the normal condition of the bed. The most natural explanation of the irregularity is surface action and hill-side pressure, though the coal itself is quite pure and solid. We are disposed to regard the King Coal as more nearly the equivalent of the Cook Bed than of any other. The rock found some distance above it resembles the "Big Rock" sandstone.

The whole neighbourhood of these natural and artificial developments is one of much obscurity and confusion. Systematic exploration is necessary to unfold its structure.

At Fairplay, one-third of a mile above the King's Coal opening, the dips are E., into a basin which passes about 100 yards E. of the tavern. 200 yards E. of the tavern is Richard Foster's old coal-opening upon the Creek side. The dip of the bed is gently E. This is owing to a slight roll of the strata dipping W. into the basin between the mine and Fairplay. The mine is now closed. The bed is said to be upwards of 3 feet thick. The roof is dark olive slate 4 feet thick, overlaid by the same thickness of pale-blue, apparently calcareous sandstone. The floor is of ash-coloured argillaceous shale 10 feet thick, containing a few nodules of iron ore, underlaid by 1 foot of blue sandstone, resting on 10 feet of black slate, which encloses two bands of nodular ore 2 or 3 inches thick.

On the S. side of the ravine, opposite Foster's Coal-bank, a shaft was sunk by Mr Richey upon a seam evidently higher in the series than Foster's, and apparently the Cook Bed. It rests upon olive shale, and is overlaid by sandstone. The coal, including a mid-rock slate, is 5 feet thick.

One-third of a mile above the shaft is the Old Lear opening, at the base of Round Knob. The following are the dimensions of the coal, which dips 3° W. :—

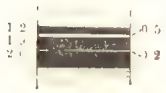


Fig. 321. Lear Bed.

Coal, 1 foot 2 inches; Slate, 5 inches; Coal, 1 foot 9 inches; Slate, 2 inches; Coal, 2 feet.

The upper bench is the best; the lower is sulphurous and bony. It is thought to be the Cook Bed.

Above the Lear Coal-seam a stratum of limestone was found. It is a bluish black rock 3 feet thick, containing Septaria, or clay concretions, some of which are soft, others hard, with dark calcareous spar, or traversed by plates of opaque white spar. In it are found univalve and bivalve shells and corals.

About three-fourths of a mile above Fairplay, or Six-mile Run, a massive ledge of coarse sandstone displays itself, showing a very gentle N.W. dip, which is much obscured by innumerable cross-joints or cleavage-planes inclined E., but nearly perpendicularly. The ledge may be seen

for some distance along the hill-side upon the N. On a branch of Six-mile Run, sometimes called Shreeve's Run, coming in from the S., at the E. base of Round Knob, and not more than half a mile from Six-mile Run, a rock identical in character, and unquestionably representing the Seral conglomerate, stands forth below Mr Cheyney's fields. The outcropping face of this rock forms a precipitous ledge 30 feet high, and the bedding inclines at a low angle (5°) N.W. under Round Knob. As is usual with this stratum, it is intersected by cross-joints dipping 85° S., 65° E. A few hundred yards higher on Shreeve's Run, and on the opposite side, the same rock enters with a very gentle E. dip into Shreeve's Hill or the S. prolongation of Anderson's Hill, which lies to the N. of Six-mile Run. The anticlinal ranges, therefore, through the ravine of Shreeve's Run, between the two exposures.

On the E. slope of Round Knob, back of the conglomerate cliff, in a field belonging to the John Griffith farm, now the property of English, Colwell, & Co., a drift enters upon a coal corresponding in position and character to the Cook Bed. Its subdivisions are as follows :—

Coal, 1 foot 6 inches (the bed lies nearly flat) ; Slate, 3 inches ; Coal, 1 foot 9 inches ; Slate, 8 inches ; Coal, 10 inches.

About 35 feet stratigraphically below this bed, another has been proved by shafting in another part of the same field. It is 3 feet thick. The shales over this coal contain numerous impressions of leaves and shells.

On the S.E. slope of Round Knob, overlooking the depression at the head-waters of Long Run, which flow S.W. into Sandy Run, a series of shafts, conducted by Messrs Richey & Foster, enable us to present the accompanying tolerably complete section of the Coal strata.

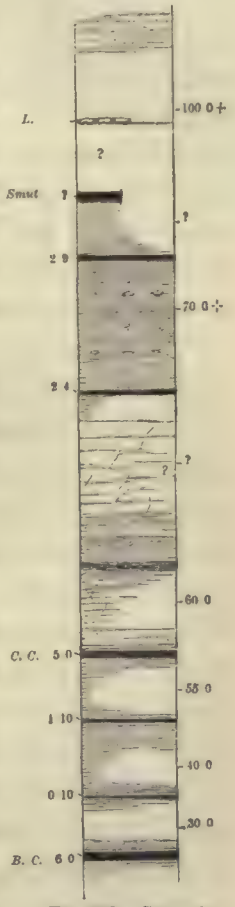


Fig. 322.—Strata in Round Knob.

1. The lowest opening is about 35 feet above the foot of the slope, bordering the gently deepening hollow. The bed of coal here proved is 6 feet thick, and is not divided by any slate-bands. The dip of the seam, in common with those on this side of Round Knob, is gently N. 40° W. into the hill.

2. Thirty feet above the coal, in the lower shaft, a bed was cut, measuring 10 inches, with a slate-roof.

3. Forty feet higher, a coal, 22 inches thick, of good quality, fracturing in rhomboidal blocks. Floor, a sandy shale ; roof, shale with impressions of leaves. This is doubtless the same seam as that met with on the E. side of the knob, as above mentioned.

4. Thirty-five feet higher, a coal 5 feet thick, including a band of slate 6 or 8 inches thick, 1 foot from the bottom. The upper slate of the Cook Bed, its equivalent, was not met with in this shaft, which, however, did not cut into solid coal.

5. Sixty feet above the last, a shaft penetrated 22 feet from the surface. At a depth of 5 feet, fire-clay was encountered : it proved 15 feet thick. The lower 5 feet contained many balls of argillaceous brown iron-ore. Below this, a black slate, 10 inches thick, presented itself, underlaid by sandstone. Above the shaft, a fine close-grained argillaceous sandstone, known as the "Whetstone Rock," outcrops upon the hill-side, and above it fragments of the "Big Rock" sandstone are visible in the more steeply-inclined slope, which its presence causes.

6. A coal 28 inches thick underlaid by sandy ferruginous shale. It corresponds in position to a coal-bed opened by a tunnel on Long Run, above the Hopewell Company's Mine, to which we may hereafter advert. Between this coal and that above it, a hill-side gutter exposes olive and dove-coloured shales, including a thin

bed of coal-slate, and several bands of fire-clay, containing nodules of brown ore. The dip of these measures is 12° N.W.

7. Seventy or more feet above the last-mentioned coal is a bed 33 inches thick, and free from slate.

8. Twenty-five feet higher, among olive shales, a thin smut of coal betrays the proximity of a seam which has not been opened. Above it are fragments of a loose-grained sandstone weathering deep red. We shall presently show that a similar rock overlies a large bed of coal, which occupies a position very high in the series on Long Run.

Above these indications of coal there are fully 100 feet of strata occupying the summit of the hill. They consist of shales capped by shelly sandstone. On the W. side of the synclinal of Round Knob, in E. Foster's fields, occurs an ash-coloured limestone stratum which should be found in this interval, though it there occupies a much lower level, which may be accounted for by the unsymmetrical denudation of the synclinal basin of the knob.

The range of the synclinal flexure, as observed from the elevated summit of Round Knob, carries it N. through Anderson's Knob and S. into Schwartz's Knob.

The first appearance of coal on Six-mile Run, E. of the bold sandstone exposure, is at Amos Figard's opening, which is one of the oldest in the region, having been made sixty years ago. The bed is 28 inches thick, and inclines gently E. It must, therefore, be upon the E. side of the Shreeve's Run Anticlinal, and cannot be many feet above the lower Seral sandstone.

One fourth of a mile further E. is the Old Loy and Patterson Mine, upon a coal lying at the N. base of Shreeve's Hill, and upon the E. side of a basin ranging through that hill. The dip is 5° W. The roof of the bed is a coarse sandstone, 5 feet thick, containing pebbles of milky quartz. The floor is of dark sandstone, full of vegetable impressions and layers of slate. The coal at the mine is 5 feet thick on the outcrop, but increases to 9 feet, and is 7 feet thick where the workings were abandoned. The opening was long since closed, but the coal is said to be free from slate, and of good quality. It occupies a position evidently low in the series, and is probably the equivalent of the Barnett Seam.

A fourth of a mile above this opening are sandstone bluffs, referable to the lower Seral conglomerate, dipping 5° W. Indications of coal were found on the road passing above these rocks. This is probably the outcrop of A. Figard's coal on the E. side of the basin. Three or four hundred yards higher up the creek, on the hill-side, slate and coal have been excavated, but the strata are not now visible in place. The dip is no doubt E.

We find no further positive developments of coal until we approach the Mountain House, upon the main plateau of the Broad-Top, at the head of Six-mile Run. Half a mile above the last locality of coal above alluded to, is Anderson's Mill, 150 yards E. of which we find the hill-side strewn with large masses of conglomerate rock, containing pebbles of nut and pea size. We are disposed to refer these fragments to the sometimes conglomeritic sandstone which overlies the Cook Bed. Near by, upon the road-side, at the base of the hill, Westward-dipping slates are exposed, supporting a coal-bed, whose presence is indicated by its smut. Between this point and the Mountain House we find no further exposures, if we except the olive sandy shales cut in places by the roadway ascending the hill.

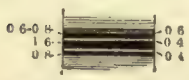


Fig. 323.—Coal near "Mountain House."

N. of the Mountain House 150 yards a coal-bed has been opened for mining upon a dip of 12° or 15° N., 60° W. It presents the following divisions :—

Coal and slate, 6 inches ; Coal, 6 or 8 inches ; Slate, 3 or 4 inches; Coal, columnar, 1 foot 6 inches ; Slate, 5 or 6 inches ; Coal, 8 inches.

This seam is denominated the "Spier Bed," and is generally regarded as overlying the Big rock sandstone, and consequently as superior in position to the Cook Bed. A second drift upon the same coal enters N.E. of the first opening. No change is perceptible in the bed, except an increased thickness of the upper dividing-slate, which measures 6 inches. Roof, blue, sandy, somewhat micaceous shale, 10 feet thickness exposed; dip as before. A short distance N. of the first mine, and at a somewhat lower level, a shaft was sunk from 30 to 40 feet, but cut no coal. It passed through shales to a bluish-grey variegated fine-grained sandstone.

On the cross-roads at the Bethel Church the dips are still W., but an anticlinal ranges through the high ground of the Hoover Place, E. of it. This throws E. dips into the valley of Trough Creek, on which, near the Fort Littleton road, and fully a mile from the Bethel Church, is the Old Houpt or Alloway Mine, alluded to in an earlier part of this Chapter.

The waters of Long Run, which take their rise from the high W. slopes of the Broad-Top to the S. of Shreeve's Hill and Round Knob, flow S. until they unite with Sandy Run, flowing more nearly W., to enter the river just above Hopewell. The lower part of the stream, outside of the Coal-measures, is usually denominated Castillo's Run. Observing the system hitherto adopted, we will ascend the deeply-cut ravines occupied by these waters.

Sandy Run, below its confluence with Long Run, a mile E. of the river, displays the coal strata more satisfactorily than they are developed on Six-mile Run.

Along the wide open valley of Castillo's Run the hill-sides expose red shale of the Umbral series, gently undulated by one or two axes of elevation. At the point of the hill entering the gorge of Sandy Run, about half a mile E. of the Machine Shop, a thorough cutting of the railroad exposes about 75 feet thickness of rocks beneath the Seral sandstone or conglomerate. The lower 40 feet comprise yellow and brown shales and sandstones, including near the bottom a thin band of carbonaceous slate. The upper 35 feet include 2 feet of blue ferruginous concretionary shale, some of which has been extracted as an iron ore; also a thin band of coaly matter, upon which repose rusty brown sandstones. Entering the cut from the W. the dips are Westerly, but roll over gently into E. dips, and are again lifted upon two abrupt, narrow anticlinal waves, descending finally beneath massive ledges of the Seral conglomerate. This latter rock flanks the point of the hill on the E., rising to a height of 100 feet above the stream. It is a white fine-grained sandstone in the lower part, becoming conglomeritic towards its upper limit. The thickness of two ledges comprising the stratum does not exceed 50 feet; dip, 40° S. 60° E.

Close beneath a third heavy ledge of sandstone, and not more than 20 feet above the Seral conglomerate, the lowest workable coal-seam is opened. The thickness of the bed is quite variable, ranging from 4 to 8 feet. It is comparatively free from slate, the only persistent band being 4 inches thick, and within a foot of the top.

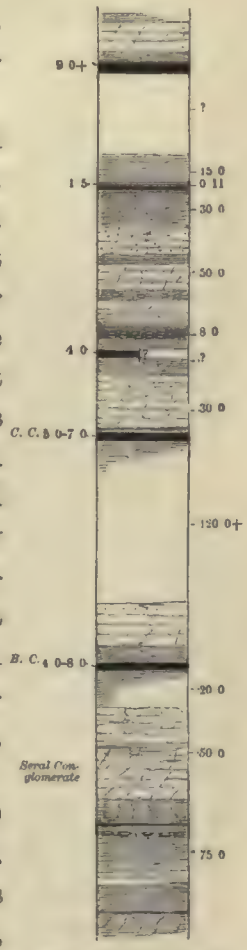


FIG. 324.—Sandy Run.

The second bed of coal opened on Sandy Run is that mined by the Hopewell Coal Company one-third of a mile further E. It is usually regarded as the Cook Bed, and is esti-

mated to lie 120 feet higher in the series than the conglomerate coal. In the Company's mine it presents the following dimensions :—

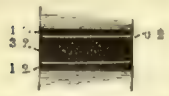


Fig. 325.—Hopewell Company's Coal.

Coal, 1 foot ; Slate, 2 inches ; Coal, with a thin Slate parting, 3 feet 2 inches ; Coal and Slate, 1 foot 2 inches.

In some places the total thickness is nearly 7 feet, but the bed at the mine is soft and crushed. The dip is 65° E. In working an air-hole up the breast the bed turned flat, and it crops out some distance back on the hill. It is overlaid by at least 30 feet of hard grey sandstone, and then by argillaceous fine-grained strata, suitable for whetstones. Slaty rocks succeed, and then a dark-blue, or black, very argillaceous limestone, in which no fossils could be found. This stratum is 8 feet thick ; the lower part is ferriferous : above it a thin streak of coaly slate was found. Succeeding this is the "Big Rock," a stratum of massive white sandstone passing upward into a fine conglomerate ; between the divisions are two beds of slate, the lower of which contains some nodules of iron ore. The entire thickness of the deposit is not less than 50 feet. Its position is 60 feet over the Hopewell Company's Coal-Bed, and therefore about 200 feet above the Seral conglomerate ; dip, 75° E.

High on the hill above the Hopewell Mine, a gangway has been driven upon a coal-seam measuring from 3 to 4 feet in thickness, upon a very gentle E. dip. A line of shafts has followed the bed E. across a shallow basin, the W. dips of which are found to within a few feet of the East-dipping ledge of the Big Rock. It would appear to descend to water-level beneath that rock, and if so, should be found among the slates below the dark limestone stratum. If our identifications be correct, it corresponds in position to a bed opened above Jesse Cook's old mine on Shoup's Run, and to that proved above the Broad-Top Improvement Company's lower mines. On Round Knob it has not been opened.

The first coal-bed opened above the Big Rock is that to which Squire Horton drove a short tunnel on Long Run, just above its confluence with Sandy. The coal measures 17 inches in thickness, and is overlaid by 11 inches of coaly slate : dip, 65° S. 85° E. About 30 feet of slate and fire-clay intervene between it and the top of the "Big Rock." In the tunnel 15 feet of shale overlie the bed.

At the tunnel a brook coming in from the N. enters Long Run. About one-fourth of a mile up this stream, on its E. bank, an opening has been made upon a coal differing in aspect from those below. Its full thickness is not clearly shown, but seems to be, including slate, not far short of 9 feet. The coal is rough and somewhat slaty, but is said to burn well. The dip is 50° or 60° W. Indications of a large seam were seen on the W. side of the brook ; no doubt the E. dip of the same. The two outcrops are not 100 yards apart. Resting upon the coal is a coarse dark-blue sandstone streaked with sparry quartz, and weathering dark brown or red. We have seen that fragments of a similar rock were found high on Round Knob. The coal is perhaps the highest workable seam in the region. The range of the synclinal is S. through Cheyney Knob.

On Sandy Run, 200 yards E. of the "Big Rock," appear the W. dips of the basin. Massive sandstone strata rise above water-level to descend again within 50 yards upon an E. dip of 70°. The E. dips of this sandstone may be seen on a little stream called Mine Run, flowing from the S. into Sandy Run, near the mouth of Long Run, about a fourth of a mile from the Hopewell Mine. The dip at this point does not exceed 30°, but close above the rock a coal is

opened, dipping 75° or 80° E. The bed fluctuates in thickness from 3 to 5 feet, and is crushed and soft.

The sharp anticlinal flexure just referred to is supposed to be that which ranges across Six-mile Run, between Figard's Mill and Fairplay. On Sandy Run it is followed by a basin close upon the E. side, as the sandstones again appear upon a gentle W. dip.

From this point E. to the head of Sandy Run, a dense forest borders the stream and covers the adjoining slopes. Our data for displaying the structure of the region are limited. Good natural exposures are rare, and scarcely any excavations have been made. For a mile ascending the Run above the last neighbourhood, we find nothing to guide us; we then have rocks perhaps lower in the series than the former, dipping 30° W. A fourth of a mile higher an anticlinal crosses the stream. The W. dips incline 60°, the E. from 50° to 60°. 40 feet of sandstone are here visible, overlaid by 30 feet of olive shale, and this, by a stratum of thin-bedded argillaceous bluff sandstone 1 foot thick. The axis must range to the W. of Schwartz's Ridge. Hence to the Chivington Mine is a distance of 1¼ miles without exposures.

The old Chivington Mine is situated upon the E. side of the basin of Schwartz's Ridge or Knob. The coal dips 7° W.N.W., steepening upon the rise E. 400 yards below the mine the dip is gently E. The thickness of the bed varies from 5 to 8 feet. The roof is a hard, heavy, dark-grey or black slate, weathering with a pencil fracture. No thick seams of slate traverse the coal, which is beautifully iridescent. About 6 feet over the main bed the presence of a small bed is indicated at the mouth of the drift. Within the mine, where the roof had fallen in, two such seams were found: they measure nearly a foot each, and are separated by 6 inches of slate. We are disposed to regard the Chivington Bed as very low in position, perhaps the lowest workable bed in the series.

The few exposures observed on Wray's Hill, E. of this opening, exhibited the rocks in a nearly horizontal posture. One bed of the coal has been opened by Mr Foster, 1½ miles to E. It is said to be 6 feet thick, and horizontal.

One mile and a quarter N. of the Chivington Mine, on the side of Schwartz's Ridge, overlooking Long Run, a bed 5 feet thick is opened. Its position in the series is not determined.

At the extreme S.W. end of the Broad-Top, Kimber's Run enters the river. Hitherto this portion of the coal-field has attracted but little attention; and, indeed, to the S. of the Run there seems small promise of finding any valuable beds of coal. Upon the Run, however, and to the N. of it, in Cheyney Knob, occur some matters of interest.

About one-third of a mile from the river a rapidly-sloping ravine or depression converges to Kimber's Run. Ascending this hollow, which heads to the N.E. at the Cheyney Ore-bank, we find the Seral conglomerate a little way above the Run. It is here a dense white sandstone, some beds of which are conglomeritic: dip, 30° S.E. A short distance above it, stratigraphically, coal has been turned out by the pick; but the bed has not been regularly proved. Upon the hill-side bordering the depression upon the W., we find numerous exposures of slate dipping 80° E.: among these are indications of coal. Higher in the series, massive cliffs of sandstone stand out from the hill-side. The dip of the stratum is 85° E. In character it closely resembles the "Big Rock" over the Hopewell Company's mine on Sandy Run. Crossing the measures some hundreds of feet, we come to a coal-bed on the slope of Cheyney Knob, upon the E. side of the ravine. Coal has been dug from what appears to be a considerable seam, but the thickness of

the bed is not known. Judging from the polished surfaces of the fragments, the coal is somewhat crushed and faulty. Associated with the bed are fragments of sandstone, weathering deep red, like that seen at the opening on a large coal in the basin E. of the Hopewell Mine. If it be the same stratum, Cheyney Knob must contain an unusual thickness of coal strata, for the dip at the shaft is still E., and the hill towers high.

Near the head of the hollow, not far from the Ore Bank, a band of limestone crops out; its thickness is not ascertained, but the band is important. The rock is a dove-coloured and light-blue very fine-grained limestone, weathering ochreous yellow. It rests among olive shales, and is said to burn to a bluish-white strong lime.

The Cheyney ore-deposit is on the very top of the hill, between Sandy Run and Kimber's Run. The excavation was at one time extensive, and the ore, which is of the argillaceous brown variety, was found in irregular streaks, imbedded in sandy clay. The mine was long since abandoned, but whether for want of ore, or because of deterioration in quality, we are unable to say.

The first appearance of coal on Kimber's Run is in the bed of the stream, half a mile from the river. The bed is crushed and impure; including a thin slate-parting, it is one foot thick. It is overlaid by dense blue sandstone, and rests upon hard blue argillaceous sandstone and slate. Dip, 52° S. 67° E.; strike, N. 23° E.

Two hundred feet higher up the creek, and forty feet geologically above the small bed, two seams have been opened. They are each 18 inches thick, and separated by 6 feet of blue slate; they are overlaid by 2 feet of blue slate, supporting blue sandstone. Dip, 55° S., 67° E. There have been found on the hill-side above this opening indications of a higher bed.

Two hundred yards up the creek may be seen the centre of the basin. The E. dips are as high as 80°, the W. do not exceed 20°. Of the East-dipping strata 20 feet of slate are visible in the bed of the stream, overlaid by whetstone and slate, 35 feet thick, to the change of dip. At this point a thick mass of slate descends by a gentle curve W. to meet slate, dipping almost perpendicularly at the level of the stream. The measures here exposed resemble closely those described as overlying the Hopewell Company's bed on Sandy Run. There appears, however, at this point, a greatly increased thickness of slate. If the horizon be the same, this great development of slate may arise from a dislocation in the centre of the basin, by which slates which dip steeply beneath the water-level are again upraised to their present elevation above the stream.

Loose masses of ferriferous black limestone are found in the run at the basin. On the hill-side, sandstone overlies the slate.

Just below the forks of Kimber's Run, and 200 yards E. of the last locality, openings have been made into coal, but they are now closed, and do not admit of examination. The coal lies 30 feet beneath a cliff of coarse, blue, flaggy sandstone, weathering brown and yellow, and dipping N. 70°, W. 35°. The bed is said to be 4 feet thick. Below it a heavy bedded sandstone rises gently E., and flanks the hills on both sides of the ravine. No indications of coal are found ascending the run, and the gently undulating rise of the sandstone, which we think is the Seral conglomerate, precludes the hope of finding any.

Iron Ores.—In the preceding pages of description we have incidentally referred to those localities where iron ore has been found imbedded in the strata; but in no instance have developments been made which could lead us to infer the presence of any very valuable band

in any part of the Broad-Top Coal-field. This is particularly true of the characteristic arch of the Coal-measures, the argillaceous carbonate of iron. Perhaps the most favourable specimens of this variety were met with in the excavation of the race of Figard's Old Mill, on Six-mile Run, where a bed measuring 12 inches was found. Of the argillaceous brown ores few localities exist, besides the Cheyney pits, before described; but surface specimens of a very good quality are quite abundant on Josiah Horton's land, N. of the road from Fairplay to Broad-Top City, one mile from the former place. Scattered fragments are also found on E. Lynn's place (formerly Thomas Griffith's); but excavations for the benefit of the Hopewell Furnace, many years ago, led to no encouraging results.

AREAS OF THE COAL-BASINS OF PENNSYLVANIA.

I cannot more appropriately close this elaborate account of the several coal-fields of the mountain-chain of the State than by presenting a summary statement of their several areas in square miles. As various and very discordant estimates of the dimensions of the Anthracite Basins have already been published, I deem it proper to mention that the following have been derived from a careful equation and measurement of their areas as these are represented in the Map of the Coal-fields which accompanies this work; and as this Map is the result of exact instrumental surveys, it is not probable that the areas given can deviate far from the actual superfices of the Coal-measures. For comparison, the Bituminous and Semi-bituminous Coal-fields are also given.

		Square Miles.
Anthracite Coal-fields,	Southern or Pottsville,	122.52
	Eastern Middle,	28.45
	Western Middle,	81.53
	Wyoming or Northern,	177.43
		409.93
Semi-bituminous Coal-field,	Broad-Top Mountain,	23.80
Bituminous Coal-fields,	All the Coal-measures N.W. of the Alleghany Mountain, with the N. end of the Cumberland Basin in Bedford,	12222.04
	Total in Pennsylvania,	12655.77

BOOK IX.

NINTH PALÆOZOIC DISTRICT, OR BITUMINOUS COAL-FIELDS AND THEIR ASSOCIATED OLDER CARBONIFEROUS STRATA.

DIVISION I.

VESPERTINE AND UMBRAL SERIES IN THE BITUMINOUS COAL REGION OF PENNSYLVANIA.

TOPOGRAPHICAL RELATIONS OF THE VESPERTINE AND UMBRAL SERIES.

It has been shown that in the Anthracite region the several coal-basins are encircled by a continuous belt of the Vespertine rocks, the conglomerate of this series constituting a second or outer barrier to each coal-field. In like manner the whole Bituminous coal region, and each subdivision or basin, is enclosed by a girdle of the same formation. A marked difference, however, prevails in the topographical features connected with the Vespertine outcrops in the two districts: in that of the Anthracite a deep valley intervening between the Seral and Vespertine ridges, being scooped out of the soft Umbral Red Shale in virtue of its great thickness and high angle of dip; while in the Bituminous region only a gentle depression, the consequence of much-reduced dimensions and comparative horizontality, divides the outcrops of the two harder formations. By the great diminution in the thickness of the Red Shales, the Vespertine conglomerate is brought nearer to the true coal-rocks, and forms with the Seral conglomerate but one general elevated rim or border to the several basins. The deep erosion of the softer underlying argillaceous formations, the Ponent and Vergent rocks, has left these harder and more resisting strata relatively high, forming the margins of the synclinal plateaus of the Coal-measures. In tracing the boundaries of the several coal-fields in the introduction to Book VIII., we have been, in fact, delineating the extensive outcrop of the whole of the associated Vespertine and Umbral series, and therefore any further description of this sort seems altogether unnecessary. The reader, in tracing the course of the several belts of these, to which the map and sections will prove his surest and easiest guide, has merely to bear in mind, that the outer edge of the Vespertine series, formed by the base of the Conglomerate, usually occupies a position in the escarpment of the Alleghany Mountain, and the other elevated plateaus of the coal, about midway between the base and summit; all the lower slopes being formed by the Ponent strata. The upper margin of the series coincident with the top of the Umbral Red Shale, follows the inner edge of the depression I have alluded to, separating the Vespertine from the Seral conglomerate. This latter formation generally capping the highest summits or crests of these table-lands, the Umbral Red Shales occupy in such cases a sort of elevated terrace or shoulder on the mountains, a little below their actual tops. In those great anticlinal belts, such as Laurel Hill and Chestnut Ridge, where the denuding waters have

not penetrated to the Ponent and Vergent strata, the Vespertine rocks occupy the higher flanks, and even the summits, of the mountains which sustain the Seral conglomerate and the Coal-measures at a subordinate elevation on their slopes.

CHAPTER I.

VESPERTINE CONGLOMERATE.—GEOGRAPHICAL DISTRIBUTION.

THE geographical range of the Vespertine sandstone seems to be coextensive, at least in the region of Pennsylvania and Ohio, with that of the great Bituminous coal-basin. It not only forms the S.E. border of the coal throughout the entire length of the main escarpment of the Alleghany Mountain in Pennsylvania, but skirts it on its N.W. side, extending the whole way into Ohio. Along its outcrop in the Alleghany Mountain, it is everywhere separated from the Seral conglomerate and sandstones by a considerable thickness of the Umbral Red Shale; but this latter formation thinning out upon the N. border of the coal region in its course towards the W., the more widely spread Vespertine sandstone becomes the immediate floor of the Seral series. This coalition takes place by the final exhaustion of the Red Shale near the head-waters of the Sinnemahoning. By a similar disappearance of all the rocks of the Ponent series in the same direction, the Vespertine sandstone comes into contact, on the other hand, with the Vergent strata; and this contact occurs in the same region, or near the middle part of the N. boundary of the Bituminous coal district. The near resemblance in lithological composition of the Vespertine strata, here exhibiting the type of a very argillaceous group, and the Vergent rocks, renders their recognition in the field of their common boundary not a little uncertain; especially as there is a great scarcity of definitive fossils in the Vergent series, until we penetrate to some depth within its upper strata. Thus limited by the Seral rocks above and the Vergent beds beneath, the Vespertine sandstone skirts the coal region from the head-waters of the Clarion westward, and forms in part the N.W. boundary of the Great Basin, the whole distance to the Ohio River, and even into Kentucky.

MODIFICATIONS IN THE TYPE AND THICKNESS OF THE VESPERTINE SANDSTONE IN THE BITUMINOUS COAL REGION.

In the escarpment or S.E. front of the Alleghany Mountain of Pennsylvania, the Vespertine sandstone, no longer possessing the coarseness of a conglomerate, is an argillo-silicious group of strata, consisting of white, grey, and yellowish sandstones, with interstratified beds of dark shale and slate. Some of the shales resemble very closely in colour and composition those of the true Coal-measures, and they embrace occasional layers of dark carbonaceous slate, not unlike that which covers many coal-seams. They are generally destitute, however, of the characteristic vegetable fossils, and nowhere present us with beds of genuine coal. In this S.E. belt, or that of the Alleghany Mountain, the general thickness of the formation is between 800 and 900 feet. Thus in the bold hills on Pine Creek, between the main stream and the first fork—that is to say, about 5 or 6 miles N.W. of the front of the Alleghany Mountain—the strata

measure 850 feet. On the Old Portage Railroad, along the front of the great escarpment, the whole formation is of rather less dimensions, being not more than 750 feet in total thickness, including certain strata that form a passage between it and the underlying Ponent rocks.

This portion of the Vespertine series, in extending N.W., loses more and more its distinctive arenaceous character. We have seen already, that in the interval between the more N.W. belts, in the Anthracite region, and the Alleghany Mountain, the nearest outcrop of the Bituminous Coal-basins, it undergoes so marked a reduction in the size of its particles as to be no longer entitled to the name of conglomerate; and we now observe in advancing across these latter basins, that this general modification in the character of the stratum continues, the sandstone becoming more and more argillaceous and fine-grained, and the shales and slates augmenting in relative abundance. Accompanying these changes, there is a progressive and very perceptible declension in the thickness of the stratum in the same direction. Thus, at Ralston, which is in the second basin from the Alleghany Mountain, the formation, as now limited by us, consisting of grey and brownish flaggy argillaceous sandstone, some shales, and a little argillo-carbonaceous sandstone, presents a total thickness not exceeding 475 feet; and around the Towanda Coal-field, which is further N., but in the same general belt, it measures from 600 to 650 feet. Tracing it still further to the N.W., we find its thickness diminishing progressively, and at the N.E. end of the sixth or last basin, namely, in M^c^Kean County, in the vicinity of Smethport, it is reduced to less than 200 feet. From this district S.W., through Warren and Crawford counties, this formation changes its dimensions and its aspect much more slowly, inasmuch as in this part of its outcrop it is receding less rapidly from its S.E. margin, where it possesses its greatest development. Starting from the S.E. part of the S.E. outcrop, and comparing it as it reappears in the successive anticlinals which uplift it in Somerset and Westmoreland, we perceive it to undergo, in that quarter likewise, the same diminution of mass and reduction in coarseness from S.E. to N.W. In Laurel Hill, at the gorge of the Conemaugh, its thickness probably does not exceed 650 feet, whereas upon the Portage Railroad it is not less than 750 feet.

CHAPTER II.

UMBRAL RED SHALE.—GEOGRAPHICAL DISTRIBUTION.

This formation, which possesses so remarkable an expansion in the Anthracite district, having a thickness at its maximum of at least 3000 feet, undergoes, like the Ponent deposits, which it much resembles in composition, a very rapid abatement of its bulk as it ranges N.W., and, like that group, altogether ceases to be traceable before we reach the sources of the Sinnemahoning. It exhibits a continuous but thin outcrop along the whole line of the Alleghany Mountain; but even in that belt it is of very subordinate importance to the Vespertine sandstone. Though it does not spread far W. along the N. border of the Great Bituminous Coal region, there can be little doubt of its wide expansion in that direction, under the coal-rocks of the S. side of the slate, as will presently appear when we compare the dimensions of the stratum as seen in its various outcrops.

LAUREL HILL AND PLAIN OF WESTERN PENNA
from the Turnpike Road

MODIFICATIONS IN THE TYPE AND THICKNESS OF THE UMBRAL RED SHALE IN THE BITUMINOUS COAL REGION.

The very uniform character which this formation retains throughout the Anthracite region, gives place to one a little more diversified in the Bituminous Coal region. We have already seen, that in the most N.W. outcrops of the former district—those near the Wyoming Basin—it begins to lose the monotonous composition of a simple red shale, and to acquire a somewhat new type by the introduction of grey and greenish shales, and grey argillaceous sandstones. In that portion of the Bituminous Coal region which lies opposite to the Anthracite district, this Umbral series exhibits, in even a higher degree, this character of an alternating group. It consists usually of two or more strata of soft red and variously-coloured shales, separated by a thick interposed body of grey flaggy sandstone. Throughout all this northern district there is the same general deficiency of calcareous matter which is visible in the red shale surrounding the Anthracite basins. There is, however, a very much greater proportion of the ferruginous ingredient. It has been already shown, in the description of the Lackawanna Coal-field, that the Umbral shales even there contain, near their contact with the Seral conglomerate, a considerable quantity of iron ore, in the form of a rather crude silicious protocarbonate of iron. This ore is perceptibly more abundant, richer, and less silicious, in the part of the Bituminous Coal region now under consideration.

Tracing the formation S.W., along the E. escarpment of the Alleghany Mountain, and in the several anticlinals to the W. of this, in Somerset, Westmoreland, and Fayette counties, it gradually assumes a type more removed from that of the Anthracite region. The chief portion of the mass consists of the characteristic soft red clay-shale; but it includes a larger portion of blue, greenish, and yellowish shale or marl, and a less amount of intercalated sandstone than belongs to the stratum further N. It contains also a less abundant share of iron ore; but the feature which specially distinguishes it in this district is its calcareous matter, the quantity of which, gradually augmenting, becomes very conspicuous, under the form of a distinct limestone stratum, as we approach the S. side of the State. The limestone shows itself near the base of the formation, appearing in the more E. outcrops, namely, near the Broad-Top Basin, and in Somerset County, in the form of a very thin but continuous stratum, enlarging gradually but regularly in its extension W. and S.W., until, upon the confines of Pennsylvania and Virginia, it assumes the magnitude of an important sub-formation. In this thin calcareous member of the Umbral series of our State, we may recognise the nearly vanished marginal portion of one of the thickest and most extensive of all the Appalachian strata of the States to the S.W. and W. of us. It is nothing else than the nearly exhausted edge of the great Carboniferous or Umbral limestone of Virginia, Tennessee, Alabama, Kentucky, Indiana, Illinois, Missouri, and regions still more remote, in many of which districts this rock is the principal or only Umbral formation.

Details.—Let us now examine more in detail the features of this interesting Umbral Red Shale as they appear in some of the different localities where it has been studied. Proceeding as usual S.W., the district which first demands our attention is that of Bradford, Lycoming, and Clinton counties.

In the First Coal Basin, or that of the Alleghany Mountain, the formation possesses the composition shown in the following sections derived from localities near the West Branch of the Susquehanna.

On Lick Run, near Farrandsville, we meet with the following alternations of Red Shale and Grey Sandstone: Ascending (see Fig. 326), first, above the true Vespertine Sandstone, which here contains a few thin courses of scattered white pebbles, is a bed of soft Red Shale, about 65 feet thick, and containing two bands of nodular iron-ore. To this succeeds a stratum of Grey Sandstone, very analogous in aspect to the underlying Vespertine Sandstone; this is not less than 250 feet in thickness. Upon this there lies another Red Shale, measuring, as nearly as could be ascertained, 30 feet. Above this Upper Red Shale commences the true Coal-formation, here introduced by a mass of flaggy white sandstone, the true character of the Seral Conglomerate not appearing. One of the layers of iron ore in the Red Shale is 6 inches thick; the other, 20 feet higher, is 10 inches. The quality is good, but the quantity insufficient.

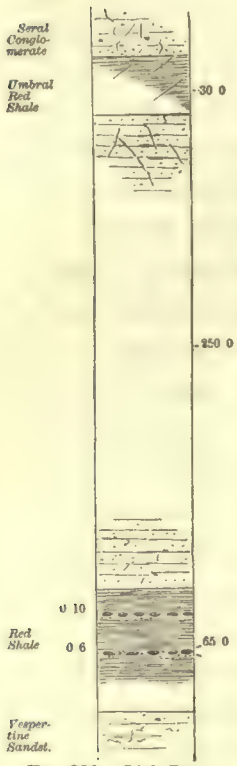


Fig. 326.—Lick Run.

On *Queen's Run*, which is a few miles E. of the previous locality, the condition of things is essentially the same. Here the upper bed of Red Shale is 25 feet thick, and the dividing sandstone 230 feet. The Upper Red Shale contains the two layers of iron ore seen at Lick Run: they are separated by variegated Red and Yellow Clay-shale.

In the Second Coal-basin the formation exhibits, at Ralston on Lycoming Creek, where only a part of it is visible, very nearly the same type, being composed of two beds of Red Shale, and an intermediate stratum of Grey Sandstone. The principal differences are in the less degree of thickness of this sandstone, and in the position of the iron ore which here occurs near the top of the Upper Red Shale, and not, as near Farrandsville, in the Lower.

The section of the strata on Red Run, about three miles from Ralston (see Fig. 327), displays the following rocks of the Umbral series, in the descending order:—

1. Blue and Red mottled Clay-Shale, containing much excellent Carbonate of Iron in nodules, 14 feet; 2. Grey Sandstone, 100 feet; 3. Red Shale, 50 feet.

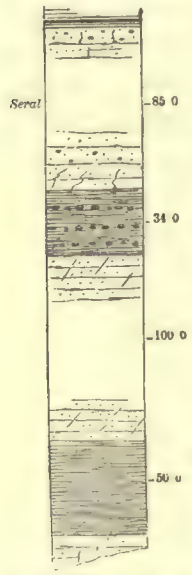


Fig. 327.—Red Run, Ralston.

The iron ore is imbedded in a mottled shale immediately under the Seral conglomerate. The layer of shale in which it is imbedded is in all about 6 feet thick, and the ore constitutes perhaps one-half of the bulk of the mass. It will be mentioned again in the chapter on the Coal Rocks of this Second Basin.

In the Third Coal-basin, at Blossburg, and farther S.W., the Umbral Red Shale presents the same triple character. The iron ore characteristic of the Upper Bed of Red Shale is here met with imbedded in olive-coloured shale, immediately beneath the Seral conglomerate. Some of this ore possesses a curious oolitic structure: it will be spoken of again in the chapter treating of the Coal Formation at Blossburg; and its chemical composition may hereafter be furnished in the Table of Analyses.

When we advance to the Fourth Basin, or that North of Wellsborough, we lose all traces of the formation, except a thin deposit of the Red Iron Ore imbedded in a narrow layer of shale. The horizon of this iron ore, which is externally discoverable by the ochreous springs, and accumulation of Bog Ore issuing from it, is discernible even in the First Basin, and also on the Cowanesque, and in the vicinity of Coudersport. It is

a good guide to the boundary which separates the Vespertine Sandstone from the Seral conglomerate.

Transferring our attention now from the country N.E. and N. of the Susquehanna to the region of the Conemaugh, we find this upper Umbral formation to undergo a great increase of thickness, and to change materially in some of its features. In the Alleghany Mountain, on the Portage Railroad, it consists of two portions, a thick stratum of red shale, measuring 370 feet, and a bed of very arenaceous limestone under this, which measures 30 feet. Between this limestone and the great Vespertine sandstone only a very thin stratum of the red shale here intervenes. The limestone is characterised by the great distinctness of the oblique planes of deposition of its more sandy layers. These meet each other at various angles in separate unconformable groups. No independent thick mass of grey sandstone, such as enters into the formation in the region of the Susquehanna, is to be met with in this more Southern district.

Crossing the Coal-basins N.W., we find the Umbral red shale exposed on the Conemaugh, near the viaduct of the Portage Railroad, and again in the anticlinals of Chestnut Ridge and Laurel Hill.

The following table represents the strata as they exhibit themselves in descending order on the Pennsylvania Railroad, S.E. side of Laurel Hill, Conemaugh Gap :—

UMBRAL.—Seral coarse grey sandstone, from 50 to 60 feet; grey argillaceous sandstone, 8 feet; white sandy shale (with grey oolitic ore, from 6 to 12 inches) 6 or 8 feet; white argillaceous sandstone and sandy clay with irregular beds of ore shale, 30 feet; white ore in ferruginous shale, 3 feet; sandy shale, 2 feet; red shale, visible, 25 feet; interval, red shale (?) 150 feet; red shale, 50 feet; white argillaceous sandstone, 20 feet; light blue sandy limestone, including 1 foot of red shale, 50 feet.

VESPERTINE.—Grey calcareous sandstone, &c. 400 + feet.

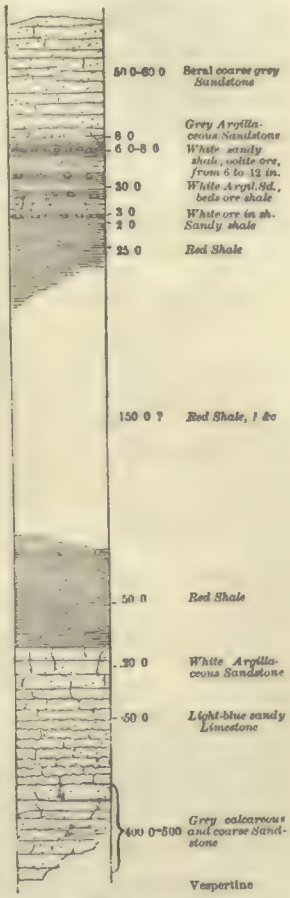


FIG. 328.—S.E. side of Laurel Hill, Conemaugh Gap.

In the following section, which is appended for comparison, the top of the formation is not clearly recognised, yet there is an obvious reduction of thickness of the mass. Umbral strata visible on N. side of Conemaugh River, at Conemaugh Furnace, N.W. side of Laurel Hill :—

Seral, loose, coarse, and fine pebbly sandstone —— (?); red and green marl alternating, red predominant, including a few thin sandy layers, 35 feet; grey fine-grained sandstone, 5 or 6 feet; impure white ore, from 1 to 3 inches; alternating red and green shale, bands of sandstone, including 6 inches coarse ore, 17 feet; argillaceous sandstone, 3 feet; red shale and green argillaceous sandstone, 3 feet; red shale, cutting out coarse grey sandstone, 10 feet; red and green shales and argillaceous sandy beds, 8 feet; calcareous sandstone, 10 to 12 feet; red sandy limestone, 3 feet; light bluish-grey sandy limestone, thick-bedded and very oblique, 40 feet; Vespertine sandstone, coarse grey and obliquely bedded, several hundred feet visible on N. side of river.

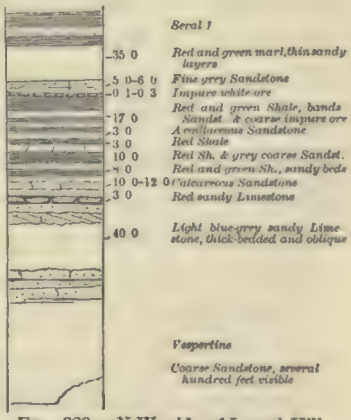


FIG. 329.—N.W. side of Laurel Hill, Conemaugh Furnace.

The strata are well exposed on the Pennsylvania Railroad in the W. half of Chestnut Ridge Gap, as follows :—

SERAL (?)—*Coal*, 1 foot; green shale and iron ore, 75 feet; argillaceous sandstone and shale, 45 to 50 feet; shale, 15 feet; *Coal*, 2 feet 4 inches; calcareous shale and fire-clay, 10 feet.

UMBRAL, 195 feet.—Interval, red shale (?) 25 feet; red marl or shale, 50 feet; grey sandstone, 5 feet; red marls, 20 feet; sandy limestone, 40 feet; olive shale, faint vegetable impressions, 55 feet.

VESPERTINE, 339 feet.—White coarse quartzose sandstone, with diagonal bedding, containing vegetable remains, 120 feet; light grey sandstone, obliquely bedded, weathering brown, 50 feet; alternation; blue sandy shales, and green and purplish marls, 35 feet; light blue massive sandstone, 15 feet; greenish and blue marl, 6 feet; light-grey micaceous and argillaceous sandstone, including 2 feet of calcareous breccia 8 feet from bottom, 48 feet; dark ferruginous shales, iron-ore balls, 10 feet; light-grey fine micaceous sandstone, massive, some shaly beds, vegetable remains, 55 feet.

VERGENT, 365 + feet.—Olive shales, thick-bedded argillaceous fine-grained sandstone, dark-olive shales and flaggy sandstone, with small carbonised stems, fucoids, 110 feet; interval, 15 feet; olive shales, layers of fucoidal grey argillaceous sandstone, some of them containing small pebbles, 30 feet; interval, 15 feet; thin-bedded fine-grained light-grey sandstone, with scolithus and fucoids, 20 feet; dark olive and blue shales, 60 feet; fine-grained greenish micaceous sandstone, 15 feet to railroad level at fault, 10 feet upthrow on E side; olive shales, some layers fossiliferous, 100 feet to river-level, loose lump containing fish scales (?)

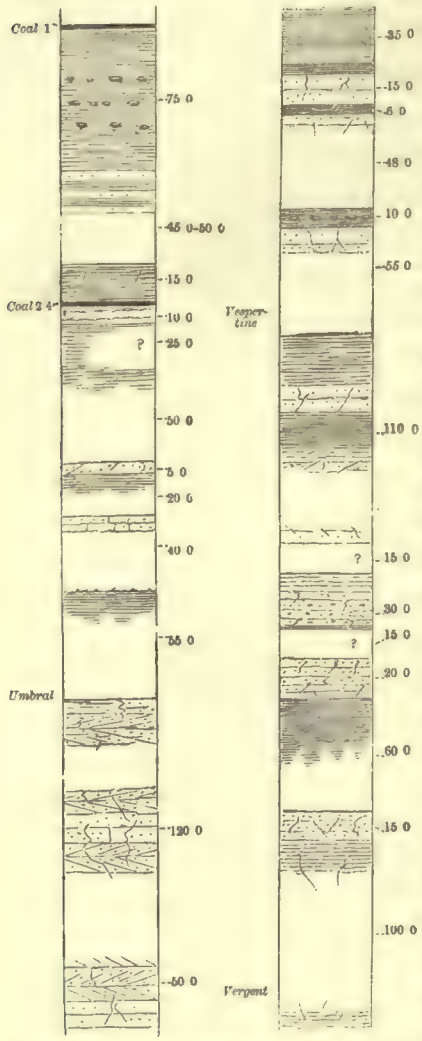


FIG. 330.—Section of Strata exposed on Pennsylvania Railroad, in western half of Chestnut Ridge Gap.

In extending W., the Umbral limestone grows gradually less sandy, and one division of it becomes charged with characteristic fossils such as Producta and other forms, distinctive of this part of the carboniferous period. In the Chestnut Ridge, as our section shows, the upper part of the formation is composed of variegated shales, red, green, blue, and even black. Some of these are carbonaceous, and distinct seams of coal are met with in them in more than one locality, showing that even previous to the production of the Seral conglomerate, there had arisen that curious union of circumstances which resulted in the formation of this inestimable gift of nature.

At Cool Spring Furnace we find two beds of coal, each about one foot thick, imbedded in these shales beneath the conglomerate. Under the coal-bearing portion of the shale there occurs a bed of blue protocarbonate of iron, in three layers of irregular nodules, some of which have a diameter of several inches.

It is not probable that any large deposits of coal will be found in the stratum of shale, inasmuch as the Seral conglomerate appears, with some exceptions in the N.W. counties, to underlie the lowermost workable coal-bed in all the coal-basins in our State; but as a depository of ore, it merits close investigation. This stratum is well exposed on the Loyalhanna near Youngstown: here its beds are red and blue, well laminated and compact, and dip 10° nearly due W. The thickness, from approximate measurements, must be 90 feet.

The Umbral limestone can be traced from the Conemaugh to the S. side of the State, along each of the main anticlinals. Throughout this region it is a more or less silicious limestone, or a limestone containing a small quantity of pure and well-rounded grains of sand, and it is of fine texture, and of a light-blue colour, though sometimes its tint is yellowish-green. On the national road it is found on the first ridge, and also on the main mountain; in the former case dipping

W. 15° N., at an angle of 25°. It lies in layers of from 1 to 10 feet or more in thickness, separated by bands of calcareous shale. The upper part is remarkably full of fossils, as is also the intervening shale. On the Loyalhanna there are two beds or layers exposed, separated by a thick bed of red and yellow shale, containing a few bands of limestone. The lower bed is a most singular rock, of a light-blue colour, and very hard; it breaks with a semi-conchoidal fracture: it dips nearly due W., at an angle of 10°. Occasionally the yellow colour predominates, giving the rock the exact appearance of some varieties of serpentine. When exposed to water it decomposes, the calcareous matter being washed away, leaving a porous and silicious crust of an inch or two in thickness, which will not effervesce. This bed measures 30 feet in thickness, being a nearly solid rock, without a seam. The upper rock is of a darker colour, harder and more fossiliferous, and 4 feet in thickness. At other points on Chestnut Ridge, this rock is met with having a considerable thickness, but no opportunity was there afforded for accurately measuring it.

On the Conemaugh, this stratum is exposed on both sides of the axis, dipping both E. and W. There is reason to believe that small quantities of lead and zinc ore may be detected in the lower beds of this deposit, particularly on Chestnut Ridge, where it seems to have reached its greatest development. Regarding it and the accompanying red and variegated shales as belonging to the Umbral formation, underlying the W. Coal-measures, the whole group will be seen to be much thicker here than further North-eastward, especially along the Alleghany Mountain, while its features are more characteristic. The dark-blue bed of limestone, which is full of fossils, usually affords an excellent lime.

On the Youghiogheny, about a mile above its falls, both beds of the limestone, the fossiliferous and arenaceous, are well exposed, and have a thickness of 30 feet. The underlying Vespertine sandstone is well seen along Sherman's Run. Beneath the clearly-defined outcrop of the massive Seral rocks, loose pieces of the iron ore peculiar to this position are seen in the upper part of the red shale.

The Vespertine and Umbral series nowhere reappear in the S. part of the Bituminous Coal region W. of the great anticlinal of Chestnut Ridge. The reader will find a detailed description of this interesting division of our Appalachian Rocks, under their more Southern type, in the reports upon the Geological Survey of the State of Virginia. In a preceding part of the present work we have detailed the special characters which the series displays in the synclinal basin of Trough Creek Valley, bordering the Broad-Top Coal-field.

DIVISION II.

GENERAL VIEW OF THE BITUMINOUS COAL STRATA.

INTRODUCTORY CHAPTER.

STRATIGRAPHICAL ARRANGEMENT OF THE COAL-MEASURES OF WESTERN PENNSYLVANIA.

UNDER the general view of the Seral series or Coal strata, I have already described (see Introduction to Book VIII.) the composition of the Bituminous Coal-measures of Western Pennsylvania, and classified them under the five groups into which they are naturally divisible; but a further more minute subdivision is called for in this place, to enable the reader to follow readily the detailed account of the coal-beds and other individual strata to be treated of in the following chapters.

The annexed analysis of the Western Coal-measures is not offered as an exhibition of their type universally throughout the basin, for that would be to assume, contrary to what has been already stated, that every member of the series is continuous and unvarying throughout this wide field. It should ever be remembered that no one locality, nor any one district even, of sedimentary deposits, can strictly represent the sediments of an area greatly more extensive than its own limits; nor can we select a given neighbourhood as a type of the whole, but merely as a specimen of perhaps its most varied features and contents. It is in this latter sense merely that the column here appended is offered as an illustration of the general contents of the basin. It is purposely compiled from observations carefully made over the extensive belt of country lying between the Alleghany and Monongahela rivers and the Western boundary of the State. Its subdivisions are therefore to be viewed as by far more correct for that district than for the country to the E. of it; and the further we withdraw from it, the less and less applicable will it prove as a guide. And furthermore, it must be borne in mind that the dimensions and features here assigned to the strata are not retained by them throughout the long belt of country from whence this synoptic view has been derived, but are only vouched for as belonging to them in the neighbourhoods whence they get their names.

A GENERAL VERTICAL SECTION OF THE BITUMINOUS COAL STRATA OF PENNSYLVANIA, WEST OF THE ALLEGHANY AND MONONGAHELA RIVERS, COMPILED FROM NUMEROUS LOCAL SECTIONS, EMBRACING THE BELT OF COUNTRY FROM MERCER TO GREEN COUNTIES.

	Feet.	In.		Feet.	In.
Blank,	200	0	Blue, buff, and olive shale,	56	0
Grey and buff micaceous slaty sandstone,	110	0	Dark-grey massive sandstone,	18	0
Dark calcareous slate,	5	0	Greenish micaceous sandstone,	44	0
Limestone,	5	0	*Limestone, thin.*		

	Feet.	In.
Yellow, blue, and brown shale,	27	0
Grey micaceous sandstone, Calcareous and buff shales, Dark-grey micaceous sandstone,	42	0

	Feet.	In.
Limestone,	0	4
COAL,	0	10
Limestone,	3	0
Shale and laminated sandstone,	15	0

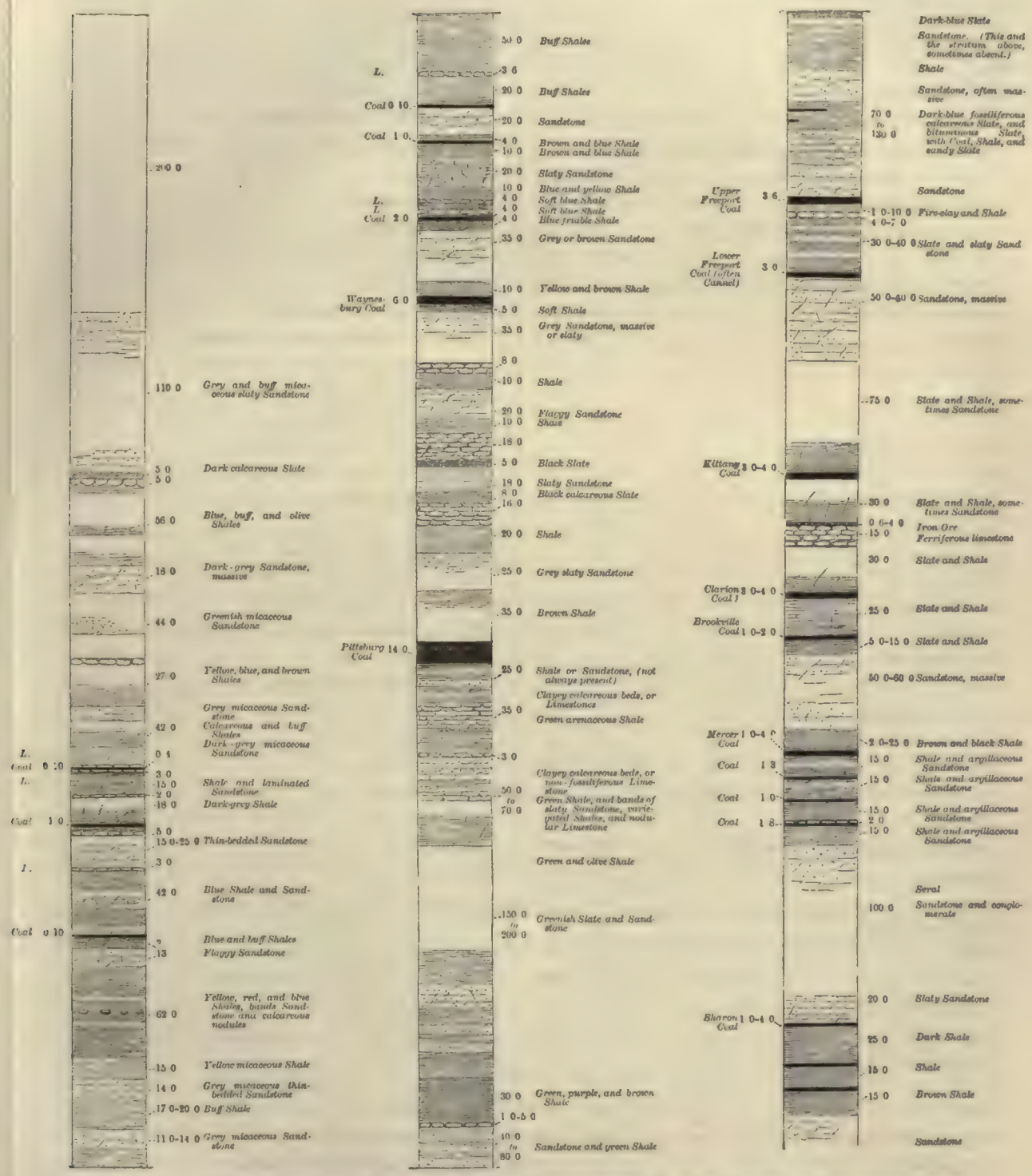


FIG. 331.—A general vertical section of the Bituminous Coal Strata of Pennsylvania, W. of the Alleghany and Monongahela Rivers, compiled from numerous local sections, embracing the belt of country from Mercer to Green counties.

	Feet.	In.
Limestone,	2	0
Dark-grey shale,	18	0
Coal,	1	0
Shale and limestone,	10	0
Thin-bedded sandstone,	15—25	0
Limestone,	3	0
Blue shale and sandstone,	42	0
Coal,	0	10
Blue and buff shale, thin.		
Flaggy sandstone,	13	0
Yellow, red, and blue shales; bands of sandstone and calcareous nodules,	62	0
Yellow micaceous shale,	15	0
Grey micaceous thin-bedded sandstone,	14	0
Buff shale,	17—20	0
Grey micaceous sandstone,	11—14	0
Buff shale,	50	0
Limestone,	3	6
Buff shale,	20	0
Coal,	0	10
Sandstone,	20	0
Brown and blue shale,	4	0
Coal,	1	0
Brown and blue shale,	10	0
Slaty sandstone,	20	0
Blue and yellow shale,	10	0
Limestone,	4	0
Soft blue shale,	4	0
Limestone,	4	0
Soft blue shale,	3	0
Coal,	2	0
Blue friable shale,	7	0
Grey and brown sandstone,	35	0
Yellow and brown shale,	10	0
Waynesburg Coal,	6	0
Soft shale,	5	0
Grey sandstone, massive or slaty,	35	0
Limestone,	8	0
Shale,	10	0
Flaggy sandstone,	20	0
Shale,	10	0
Limestone,	18	0
Black slate,	5	0
Slaty sandstone,	18	0
Black calcareous slate,	8	0
Limestone,	16	0
Shale,	20	0
Grey slaty sandstone,	25	0
Brown shale,	35	0
Pittsburg Coal,	14	0

	Feet.	In.
Shale or sandstone, not always present,	25	0
Clay, clayey calcareous beds or limestones, Green arenaceous shale,	35	0
Limestone,	3	0
Clay, calcareous beds, or non-fossiliferous limestone, Green shale, and bands of slaty sandstone, Variegated shales and nodular limestone,	50—70	0
Green and olive shale, Greenish slate and sandstone,	150—200	0
Green, purple, and brown shale,	30	0
Limestone,	1—5	0
Sandstone and green shale, Dark-blue slate, sometimes absent, Sandstone,	40—80	0
Shale, Sandstone, (often massive), Dark-blue fossiliferous calcareous slate, and bituminous slate with coal, when of notable dimensions, called the Elk Lick Coal, Shale, sandy slate, and sandstone,	70—130	0
Upper Freeport Coal,	3—6	0
Fireclay and shale,	1—10	0
Limestone,	4—7	0
Slate and slaty sandstone,	30—40	0
Lower Freeport Coal (often Cannel),	3	0
Freeport sandstone, massive,	50—60	0
Slate and shale, sometimes sandstone,	75	0
Kittanning Coal,	3—4	0
Slate and shale (sometimes sandstone),	30	0
Iron Ore,	4 in. to 6	0
Ferriferous limestone,	15	0
Slate and shale	30	0
Clarion Coal,	3—4	0
Slate and shale,	25	0
Brookville Coal,	1—2	0
Slate and shale,	5—15	0
Tionesta sandstone (massive),	50—60	0
Brown and black shale,	2—25	0
Tionesta or Mercer Coal,	1—4	0
Shale and argillaceous sandstone,	15	0
Upper Porter Coal,	1	3
Shale and argillaceous sandstone,	15	0
Middle Porter Coal,	1	0
Shale and argillaceous sandstone,	15	0
Mercer limestone,	2	0
Lower Porter Coal,	1	[illegible]
Shale and argillaceous sandstone,	15	0
Seral sandstone and conglomerate,	100	0

	Feet.	In.		Feet.	In.
Slaty sandstone,	20	0	Shale,	15	0
SHARON COAL,	1—4	0	COAL,	?	
Dark shale,	25	0	Brown shale,	15	0
COAL,	?		Sandstone,		

This extensive series of rocks, omitting the more subordinate beds of coal, sandstone, and shale, admits of being classified in accordance with the following scheme, which represents the subdivisions that have been adopted in picturing the Coal-measures upon the Geological Map of the State. The tabular arrangement, besides presenting the names employed in this work for the several strata, and the natural groups into which we have thrown them, exhibits the average thicknesses of these groups in the districts where they are best developed.

			Feet.
4.	Upper Barren Measures,		1200
	Waynesburg Group, and Pittsburg Coal and Limestone,		
3.	Lower barren Measures,	Unproductive rocks, mostly slates and shales, and containing green and black limestone bands,	400—500
	Mahoning massive bed of sandstone,		50— 75
	The Freeport Group,	Elk Lick Coal,	100—250
		Upper Freeport Coal,	
		Freeport Limestone,	
		Lower Freeport Coal,	
	Freeport, or contorted Sandstone,		15—50
2.	Clarion Group,	Kittanning Coal,	100—200
		Ferriferous Coal, wanting at the West,	
		Ferriferous Limestone,	
		Clarion Coal,	
		Brookville Coal,	
	Tionesta Sandstone,		60
	Tionesta Group,	Mahoning Limestone,	10—100
		Tionesta Coal,	
		Upper and Middle Porter Coal,	
		Mercer Limestone,	
		Lower Porter Coal,	
1.	The Seral conglomerate, embracing locally the Sharon Coal Group as a member,		50—100

GENERAL DESCRIPTION OF THE SEVERAL BITUMINOUS COAL BASINS.

To acquire a clear conception of the singular manner in which the coal strata of the bituminous region of Pennsylvania are distributed, let us, with a Geological map before us, imagine ourselves stationed at a commanding height above the surface, somewhere in the central part of the great W. basin ; say at Pittsburg. To the S. and W. there spreads an immense undulating plain, composed entirely of the Coal-measures, stretching far into Virginia, Kentucky, and Ohio. From our point of view the whole area to the S. and W. boundaries of the State to the base of Chestnut Ridge on the E., and to a line through Mercer and Franklin counties on the N., is occupied exclusively by this formation. Let us now direct our observation to the tracts which border this deep principal basin.

To the S.E. we discern a succession of long, narrow, parallel troughs, which have their general S.E. limit in the crest of the Alleghany Mountain. These are either entirely or partially insulated from the main W. basin, and also from each other, by the bold, parallel, and anticlinal ranges of Chestnut Ridge, Laurel Hill, and Negro Mountain, and their prolongations N.

Towards the N.E. the running-out of the main W. basin, and of these subordinate troughs which lie to the E. of Chestnut Ridge, is marked by some interesting features of symmetry, the clear recognition of which will materially assist us in tracing the scattered patches of the coal-rocks, by which the general mass is flanked in that direction; for, gazing from our supposed height upon the whole sloping table-land descending from the crest or escarpment of the Alleghany Mountain, to the Monongahela and Alleghany Rivers, we perceive that between these limits this broad plain is traversed in a N.E. and S.W. direction by a remarkable group of strikingly parallel and equidistant anticlinal elevations of the strata, which constitute on its S.E. side the conspicuous mountain-ranges just enumerated; and N.W. of Chestnut Ridge a succession of lower axes that continue to undulate the strata, but soon cease towards the S. to control the topography.

The accompanying general section (See Pennsylvania Central Railroad Section) of the coal-field from the Ohio River at Pittsburg, by the line of the Pennsylvania Railroad, to the summit of the Alleghany Mountain, exhibits distinctly the relative magnitudes and positions of six of the eight axes or great flexures of the strata. The *First* arch to the W. of the summit of the Alleghany Mountain upon this line of section, is in the high belt of hills which crosses the Conemaugh near the Railroad Viaduct; the *Second* coincides with the broad and massive mountain called Laurel Hill; the *Third* forms the somewhat less elevated Chestnut Ridge; the *Fourth*, a much flatter one, crosses between Beatty's Station and George's Summit; the *Fifth*, crossing the Conemaugh about 3 miles E. of Saltzburg, passes a little E. of Grapeville; the *Sixth* is a broad double undulation, one wave ranging E. of Stewart's, the other occurring at Turtle Creek (this latter developed as the principal one on the Kiskiminetas above Warren); the *Seventh* about 2 miles W. of Leechburg on the Kiskiminetas, but not appreciable on the line of our section; while yet another, the *Eighth* and last, which is parallel to all the rest, crosses the Alleghany between the mouths of the Mahoning and Red Bank creeks.—(See also Section, No. IX. of the Map.)

These great anticlinal waves of the strata prolong themselves many miles from the line of section towards the N.E. But five of them, as the map will show, are more persistent than the rest, not only extending to the Sinnemahoning and the N. Branch of the Susquehanna, but crossing those streams and controlling the whole topography still further E. and N., even beyond the New York line and the valley of the N. Branch of the Susquehanna. By these five larger axes the whole region of the Bituminous Coal has received its marked division into six separate basins, in one or two of which the other lesser axes have their more limited range; and to these the name of sub-axes will be given in the description of the region.

The influence of all these flexures upon the distribution of the coal strata, the uppermost of the formations, is very striking. By bringing to the surface lower rocks than those belonging to the Seral series, the axes of Chestnut Ridge, Laurel Hill, and the other conspicuous mountain-belts, have insulated, as we have said, the coal-rocks of the E. portion of the whole region from the rest, and thrown them into several narrow troughs. On the contrary, the axes, to the W. of Chestnut Ridge, elevate no inferior formation to the day, in the district near the Conemaugh, for the Coal-

measures constitute the lowest rocks exposed by them. They, nevertheless, throw the coal-fields, which they traverse, into subordinate troughs or basins, insulating the upper beds, and permitting the lower only to arch from one basin over into the next, as do those of Chestnut Ridge and Laurel Hill in their N.E. prolongation, where they have so subsided as to carry the strata beneath the Coal-measures out of sight.

The result of this peculiar structure (anticlinal axes and included basins) upon the distribution of the coal strata, as we trace them N.E. from the region of the Conemaugh, is simply this: the anticlinals and synclinals rising in that direction, with the general upward slope of all the strata towards New York, the basins grow progressively shallower, as respects the depth or thickness of their contained coal-rocks, and consequently the higher beds successively disappear along the middle lines of the basins, leaving only the lower ones remaining, while the lower beds are also successively denuded from the anticlinal uplifts, allowing the still lower formations to appear. These, by their emergence along the axes, invade the once continuous coal-formation, and part it into a number of strictly isolated basins.

These, which of course are but extensions N.E. of the several troughs in ranging forward separated from each other, contain less and less of the Coal-measures, both superficially and in thickness, until at last the formation ceases to be continuous, being prolonged only by a few scattered patches occupying the highest knobs of the long and narrow synclinal table-lands in which these basins terminate. Leaping, as it were, from summit to summit, these detached masses of the coal formation lead us, but often by long skips, to within a few miles of the North Branch of the Susquehanna on the E. and the New York line on the N. With these and the intervening anticlinal lines as guides, we may, in imagination, readily restore the positions of the once ample coal-basins, which overspread all the N. side of Pennsylvania. If we embrace the whole of this coal region N.W. of the Alleghany Mountain under one general survey, it presents considerable analogy in the distribution of the coal-rocks to the form of the human hand—the wide Western Basin standing for the palm, the separate continuations of the minor basins springing from this being like the fingers; while the intervening anticlinal tracts, destitute of coal, represent the interdigital spaces. The above explanation will be rendered more intelligible by a reference to the N.W. portions of the General Sections IX., VIII., VII., VI., and IV. of the Map.

The Anticlinal Axes and their intervening Coal-basins.—To acquire a more minute knowledge of the actual distribution of the coal-rocks, it is necessary to take first a rapid survey of the principal basins or troughs and the anticlinal belts which separate them. In this sketch we shall proceed, as usual, from the S.E. to the N.W., tracing each individual trough and axis S.W. as far as it will carry us. We shall begin, therefore, in Wyoming, Bradford, and Tioga counties, the quarter where the several bituminous coal-basins reach their E. termination; but for convenience sake, and for reasons that will hereafter appear, we shall describe all the region lying N.E. of the Conemaugh, separately from that which lies to the S.W. of it.

SUBDIVISION I.

BITUMINOUS COAL-BASINS NORTH OF THE CONEMAUGH AND OHIO.

CHAPTER I.

First Basin and Principal Axis N.W. of the Alleghany Mountain.—This is a long and narrow synclinal table-land, known in Wyoming and Sullivan counties as part of the Mahoopeny Mountain ; and in Lycoming, Clinton, and Centre counties, as the summit of the Alleghany Mountain. Its S.E. boundary in the former counties is determined by an axis, not numbered with the five great axes of the Bituminous Coal region, because, crossing the North Branch of the Susquehanna above the mouth of Tunkhannock Creek, it simply penetrates a S. extension of the Great Plateau, and issues from it again W. along the valley of Muncy Creek, being practically, when the whole topography of this part of the State is viewed on a grand scale, little else than the N.E. prolongation of the great axis of Bald Eagle Mountain and Nippenose and Nittany valleys. Where this axis penetrates the Alleghany Plateau, this seems to have no true coal-basin. To the S. of it the table-land of the North and Bowman's Mountain is overspread by grey Vespertine Sandstone.

The Mahoopeny table-land, on the contrary, though principally occupied by the same formation, embraces in its higher tracts a few isolated shallow patches of the Seral conglomerate and Coal-measures. The positions of these will be defined, after we have traced the basin in its prolongation S.W. (See General Section IV.)

For the rest of its length to Cambria County, the high synclinal belt containing the first range of Coal-measures is bounded by the S.E. escarpment of the Alleghany Mountain. The N. or N.W. limit of its trough is very well defined by the belt of older formations lifted to the surface on that side in a long gently-bending anticlinal axis, the central line of which passes the North Branch of the Susquehanna, near the Wyalusing Falls, and the West Branch above Rattlesnake Run.

From the North Branch of the Susquehanna, nearly to the waters of Lycoming Creek, the rocks exposed along this anticlinal belt are the upper members of the Vergent Series and the Ponent strata ; from Lycoming Creek, on to the West Branch, they consist chiefly of the Vespertine Sandstone ; from the vicinity of the West Branch to the Moshannon, the only formation on the surface arching the anticlinal line is the Seral conglomerate.

About 3 miles S.W. of the Moshannon, the tract of conglomerate tapers to a point, and the Coal-measures themselves, in their lower members, there saddle the arch, and cause the two basins—before divided as coal-basins—to coalesce as a continuous field. From this point S. the axis grows rapidly less conspicuous, so that its prolongation, even across Clearfield Creek, is somewhat questionable, while there can be little reason to doubt its reappearance upon the Conemaugh in the great axis of Laurel Hill.

The long synclinal belt contained between the above axis (No. 1) on the N.W., and the Muncy Creek axis and escarpment of the Alleghany on the S.E., though geologically entitled to the name of a trough or basin, is, as we have seen when considering the topographical features of the region, rather a high strip of table-land, which the hard silicious rocks below the coal have protected from denudation. The coal-rocks, the appropriate position of which is towards the middle of this table-land—that is, along the deepest or central line of the geological basin—by no means extend continuously along its summit, but are restricted to a few isolated localities by the converging dips of the lower strata, and occupy a medial line along the trough. An escarpment of the Seral conglomerate, upwards of 60 or 80 feet high, generally rises from the naked table-land of the Vespertine Sandstone, and marks approximately the margin or outcrop of the lowest coal-seam, which is here adjacent to the conglomerate. In these detached outliers we seldom find more than the three lowest coal-seams left, so great has been the destruction of the Coal-measures ; and in the most Eastern or terminal patches we rarely

encounter more than the first or second: therefore the total thickness of the coal-rocks above the conglomerate hardly exceeds in these cases 100 or 200 feet. Approaching the portion of the basin where they become continuous, their thickness of course augments.

The most Eastern tract of the Coal-measures in this basin is at the head of Mahoopeny Creek. The next patch W. of this is between the Big Loyalsock and its N. tributary, Birch Creek. In the latter locality there is one coal-seam over the conglomerate, about 2 or 3 feet thick, but it is more circumscribed than that rock in the area bounded by its outcrop: besides this one, there is a thinner seam imbedded in the conglomerate.

The high hills near the mouth of Plunket's Creek are capped by the Seral conglomerate; but no overlying coal-seam has been discovered on them.

The coal makes its appearance along the summit of the Alleghany Mountain at one or two points between this and the knobs W. of Pine Creek. On the W. side of Hogeland's Run there occurs coal 5½ feet thick, divided by 2 feet of fire-clay, and the outcrop probably of the same bed occurs on the summit, N. of Tombs' Run and overlooking Pine Creek.

Between Pine Creek and the Susquehanna West Branch, more especially around the tributaries of Queen's Run and Lick Run, there spreads a considerable patch of the formation. The maximum thickness of the Coal-measures in this neighbourhood is about 150 feet; the number of coal-seams is four: only three of these have such a thickness as to be valuable. In this tract are the mines from which it was intended to supply the Farrandsville Iron Works with fuel. Even here, a few hundred acres will most probably be found to embrace the whole of the productive Coal-measures, though the conglomerate, the usual external index to the coal, covers a considerably wider area. From the neighbourhood of the Queen's Run Mines, a long narrow ridge called Sandstone Hill marks the central line of the basin, extends E. to the turnpike, and protects the coal-bed, whose outcrop is there visible.

Passing now to the W. side of the Susquehanna, we come, after an interval of a few miles, to another isolated coal-tract between the forks of the Tangascootac Creek.

From this point to the Moshannon, the formation, although still extensively wasted and occurring only in a range of patches between the deeply denuded ravines of Beach Creek, begins to become continuous, and to present the outlines of a regular basin. In these tracts, where as yet no mining operations of any magnitude have been attempted, the ordinary number of coal-beds is two, or at the most three. One of the seams which is wrought to a small extent at Snow-shoe, probably the second or third in ascending order, is about 6 feet thick.

From the vicinity of Snow-shoe, which lies between the head-streams of Beach Creek, the Coal-measures may be regarded as extending S.W. in a narrow but continuous basin, confined principally to the N.W. side of the Big Moshannon, until within a short distance of Philipsburg, where the formation rapidly widens and increases somewhat in depth. Near this village the S.E. outcrop of the coal is within 1½ miles of the E. crest of the Alleghany Mountain.

From Philipsburg S.W., the centre of the basin coincides very nearly with the general course of the Moshannon Creek—the strata on each side dipping gently toward the stream. In Coal Hill there are four seams of considerable thickness.

The N. W. boundary of the trough lies from 2 to 3 miles N.W. of the Moshannon, in a high broad ridge, by which the first axis here begins to exhibit topographically its geological form.

A shallow depth of the coal-rocks, comprising probably only the lower seam, arches over this ridge, and thus connects the first with the second basin.

Whether the axis of this ridge, preserving its gentle sweep, and converging towards the N.W., becomes that of Laurel Hill, towards which it seems to point; or whether these two lie out of line like the sub-axes of Somerset County, hereafter to be described, has not been positively ascertained. S. of Mount Pleasant, the first basin loses its definiteness also, and, passing Ellensburg and the Pennsylvania Railroad, the widening space between the crest of the Alleghany and the Laurel Hill Axis, becomes separated into two, and finally into three basins, by the occurrence of anticlinal axes not developed further N.

CHAPTER II.

SECOND BASIN AND AXIS NORTH-WEST OF THE ALLEGHANY MOUNTAIN.

THE next basin is that which contains the Towanda, Karthaus, and Clearfield coal-rocks. Like that of the first basin, its N.E. extremity in Bradford and Lycoming counties is a long narrow table-land, elevated nearly 1000 feet above the general water-level of the adjoining anticlinal valleys which bound it on the N. and S. The valley of the Towanda Creek is its immediate boundary upon the N. As in the case of all the N.E. terminations of this group of basins, the table-land which represents the more central parts of the trough, ranges as we trace it S.W. into a general high plain, where the anticlinal axes on the N. and S., instead of coinciding with valleys, are marked by broad swelling ridges, between which, as we proceed, the coal-formation assumes more and more the form of a basin, subsiding into a regular though gentle valley-like depression.

Second Coal-Basin, Towanda Mountain.—The anticlinal axis No. 2, which limits the basin on the N., exposes, from Towanda to the sources of the First Fork of Pine Creek, a narrow central tract of Vergent rocks, margined by the overlying Ponent strata, and forming a rough natural valley. From the First Fork to the Run called Chinchelamoose, in Clearfield County, it cleaves a long high belt of Umbral strata capped over large areas by the Seral conglomerate. The top of this anticlinal arch is traceable from the Northern waters of Wyalusing Creek across the North Branch of the Susquehanna at the Wysox bend, and thence up the centre of the denuded valley of Towanda Creek, below the second fork of Pine Creek, and crosses the Sinnemahoning a little E. of the junction of the Driftwood and Bennett's Branch, where, deflecting more S.W., it traverses a wilderness country to the Chinchelamoose Run, and there enters the Coal-measures. It is prolonged through the highland called Grampian Hills, and past the falls of the South Branch of the Susquehanna, beyond which it ceases in a few miles to be definitely marked; but probably, like the first axis in this same region, it sinks only to rise in bolder outline as the master axis of Chestnut Ridge.

From the Clearfield and Brookville Turnpike S.W. it is saddled by the lower coal-seams, and thus the second and third basins coalesce.

The long narrow trough in the strata, bounded on the N.W. by this second axis, does not embrace the coal-measures continuously, Eastward of the mouth of Kettle Creek, on the West Branch of the Susquehanna. Between this point and the North Branch it is a high table-land, contracting as we go eastward to a breadth of from five to seven miles, overlaid by the Vespertine sandstone, and capped in three or four localities by the coal-rocks. These latter strata consist of the Seral conglomerate, sometimes supporting the two or three lower coal-seams, sometimes entirely denuded of the proper coal-measures. Only two detached masses of the formation are here worthy of especial notice. The largest, and from its position the most important patch, is that which overspreads the highest summits between the Towanda Creek, and its middle and south branches. The other is on Lycoming Creek, north of Stony or Rocky Run, and around the sources of this stream and of Frozen Run.

Towanda Coal-field.—The Towanda coal-field has its Eastern termination on the brow of the mountain between the South Branch and the Carbon Creek, or the Middle Branch of Towanda Creek. Its Western limit is near the township line of Franklin. The Coal-measures, which occasionally embrace the two lower seams, occupy only the highest land, and form a rather narrow tract lying in an E. and W. direction. The whole of the coal lies within an area less than thirteen miles in length and four in breadth; but it is fair to infer from the gashed and denuded condition of this mountain summit, that the productive part of the formation does not constitute more than one-fourth of this surface.

The Lycoming or Ralston Coal-field.—The physical features of the Lycoming, or Second outlying Coal-field in the line of the present basin, are analogous to those of the Towanda tract. It caps a narrow part of the synclinal plateau in a series of detached flat knobs, and crosses Lycoming Creek as a narrow belt about seven miles long by less than two wide, the continuity of the coal-rocks being greatly broken by deep ravines and mountain valleys. Three coal-seams of useful dimensions occasionally occur, as at the mines near the head

of Stony Run; while a fourth is at one place workable; and a fifth, low down near the conglomerate, also attains at one place a thickness of two and a half feet.

On both sides of Pine Creek, but especially on the Eastern, between the main stream and the First Fork, wherever the hills in the centre of the basin have a considerable elevation, the Seral conglomerate occurs in patches, and in one or other locality is accompanied by traces of the lowest coal-seam.

On the highlands between Drury's and Paddy's runs, and the Susquehanna and Kettle Creek, along Boon's Road, isolated patches of coal-rocks occur, and remarkably uniform traces are frequently visible, making the outcrop of the lowest coal-bed above the conglomerate.

But we may say that the regularly continuous Coal-measures of the Second Basin begin near the mouth of Kettle Creek, and follow thence the general course of the Susquehanna to its source, or at least as far as Canoe Place, at the S.W. corner of Clearfield County.

From near Clearfield to Kettle Creek the river flows nearly along the middle of the trough, supported by the Coal-measures as far as Moravian Run; but from this stream to the influx of Kettle Creek it cuts through into lower rocks, and cleaves the coal into two high narrow belts, one on each side of the deep trough in which the river winds. As the basin progressively deepens from the Sinnemahoning S.W., it embraces in that direction a very valuable thickness of useful mineral strata; and here, too, we first meet with those singularly persistent seams of limestone alternating with the coal, which prove such invaluable guides in identifying the series of coal-rocks over the whole region to the South and West.

At Karthaus the total depth of Coal-measures above the Conglomerate is at least 320 feet, in which are included nine beds of coal of various dimensions, besides beds of fire-clay and iron ore. (See Subdivision III., Chap. VIII.) It is probable that along Clearfield Creek, which for some miles seems to flow nearly centrally along the basin, the average thickness of the coal-formation is as great as at Karthaus.

The exact course of the basin S.W. from the head of the Little Clearfield Creek is not fully known; but little doubt can be entertained of the prolongation of the trough into that of the Ligonier Valley, between the axis of Laurel Hill and Chestnut Ridge. Should such be the case, we behold in the basin before us one of the most remarkable synclinal depressions anywhere discovered, whether we advert to its extraordinary length, to the regular sweep of the axes which bound it, or to their wonderful parallelism.

CHAPTER III.

THIRD BASIN AND ANTICLINAL AXIS.

BETWEEN the anticlinal valley of Towanda Creek, and the similarly-constructed broader valley-belt of Vergent and Cadent rocks of central Tioga County, on which are the sites of Covington and Wellsborough, we encounter a third synclinal table-land, ending abruptly N. of the village of Canton Corners, and marking the termination of the Third Basin.

Originating, as mentioned, between the Forks of Sugar Creek, E. of the Tioga County line, it extends as a narrow irregular detached plateau, nearly to Pine Creek, where it joins the general table-land of the country. From its Eastern termination at Canton Corners to Bennett's Branch of the Sinnemahoning, the whole belt included in the Basin is generally overspread by the Umbral shales and Vespertine sandstone, supporting near its central line a few isolated tracts of the Coal-measures, and a rather larger number of the patches of the Seral conglomerate, from which the superincumbent coal-rocks have been entirely swept off. Immediately S.W. of Bennett's Branch, we enter upon the continuous Coal-measures of this Basin, which extend thence in a regularly thickening mass to the Conemaugh.

The anticlinal axis which confines this long and narrow trough on the N.W. axis No. 3, approaching from the N.W. corner of Susquehanna County, crosses the North Branch a little below Tioga Point, the Tioga River about two miles North of Covington, and Pine Creek near the Round Islands. Thus far it elevates a wide belt

of the Vergent and Cadent strata, margined by the Ponent red sandstone, here much attenuated in thickness.

From Pine Creek its range is S.W. to Trout Run of Bennett's Branch, which it crosses about three miles N.W. of Winslow. Beyond this point, it sweeps steadily to the southward, through the high range of the Elk Mountain, crosses the East Branch of Sandy Lick Creek, near the Western line of Clearfield County, and passes about two miles West of Punxutawney. Its course thence to the Kiskiminetas, or Conemaugh, is slightly irregular, intersecting Little Mahoning Creek, East of Smicksburg, passing close to Middletown, and crossing the Kiskiminetas about three miles E. of Warren, or a little E. of Roaring Run (Routing Run on the Map).

From the Round Islands on Pine Creek to the East Branch of the Sinnemahoning, the third axis exposes, for the greater portion of the distance, a belt of the Vespertine sandstone, although in crossing the eastern streams of Kettle Creek it exhibits upon the sides of their deep valleys the Upper Vergent rocks and the thin Ponent series; for it must be held in mind that the general water-level of the streams which reticulate the whole of this vast region is always many hundred feet below its plateau surface. Beyond the Sinnemahoning, as far as the S.W. termination of the Elk Mountain, the coarse rocks of the Seral conglomerate rise high upon its sides, while the Umbral Red Shale arches over it at its surface stratum. But at the Southern end of Elk Mountain the Coal-measures, encroaching from both sides upon the stratum of Seral conglomerate, unite or close over the axis before it reaches the East Branch of Sandy Lick, and from this point of junction, to the termination of the axis S. of Kiskiminetas, it is arched by a thicker and thicker body of coal-rocks.

The Blossburg Coal-field.—The only one of the detached coal-fields appertaining to the Third Basin which merits a place in this general description—indeed, the only one of any magnitude—is that of Blossburg on the head-waters of the Tioga River. It lies N. of the upper part of the river, the part that flows from E. to W. along the middle of the trough, partly in Bloss and partly in Ward townships, and extends about eight miles Eastward from Blossburg in a narrow elliptical form. The total thickness of the Coal-measures is about 200 feet, the hills containing the formation having an elevation of about 400 feet above the bed of the river. The coal-seams near Blossburg, counting great and small, are about nine in number; five of these being small non-persistent beds, and the others not averaging more than 3½ feet in thickness, excepting at one locality on Morris Run, where the main bed exceeds 5 feet in thickness. They are accompanied by beds of fire-clay, and some iron ore; but, as in all these extreme N.E. prolongations of the several basins, limestone seems wholly wanting. (See sections at Morris Run and Blossburg.)

Between Boon's and Johnson's Creeks, about three miles Westward of the Tioga River, and in geological line with this main field, there is a much smaller and thinner patch of the coal-rocks, including probably a few of the lowest seams.

In the same line, still further to the S.W., is another still more shallow portion of coal-rocks. This ranges across Wilson's Creek to Stony Fork, and lies between 8 and 9 miles S. of Wellsborough. Here are two beds, both of moderate size.

Though many outlying patches of the Seral conglomerates occur along the middle of the trough, from Pine Creek to Driftwood Branch, that rock in all this distance nowhere supports any tracts of the Coal-measures, or none deserving consideration here. On the W. side of the Driftwood a single seam has been discovered, near the level of the highest land, but occupying a very circumscribed area. The cause of this is to be found in the unusual narrowness of the Basin here, with no increase of steepness in its synclinal dips.

The Coal-measures begin to occupy continuously the third basin at Bennett's Branch of the Sinnemahoning, S.W. of Trout Run; the former stream, from its source to within 2 miles of the latter, flowing nearly in the centre of the trough. From Sandy Lick Creek and Anderson's Creek S.W., the Coal-measures of this basin are united with those of the adjoining second and third basins across the intervening axes; but from these streams N.E. the belt regularly tapers and grows shallower to its termination at Trout Run.

At Caledonia, on Bennett's Branch, about 5 miles above the mouth of Trout Run, the coal-rocks, including the conglomerate, which is about 100 feet thick, compose nearly the entire series of strata from the flats of the stream to the hill-tops, making in all a thickness of about 500 feet. In the 400 feet of Coal-measures occur

6 distinct seams of coal, 3 of these possessing sufficient thickness to be valuable. There are likewise 3 or 4 beds of limestone, and some layers of shale rich in iron ore.

Where the Brookville and Clearfield Turnpike crosses this basin, the lower beds of coal arch over the third axis on the W. into the fourth basin, while in the centre of this third basin 3 seams of coal have been proved, while two others may possibly exist: near the hill-tops a bed of limestone is also found.

At Punxutawney the W. or third axis has so subsided that the limestone (known by us as the Freeport Limestone) and underlying coal-bed (here the only valuable one, and 8 feet thick) outcrop upon it, while a very great depth of the still higher unproductive measures cover the surface, or fill the bed of the basin itself. These, as we pass on S., still increase in thickness, until, to the S.W. of the town of Indiana, and along the centre line of the basin, we find the great Pittsburg coal-seam, capping the highest knolls between the streams, itself sinking deeper and deeper very gradually under overlying rocks, until, at the Kiskiminetas, 3½ miles W. of Saltzburg, not less than 175 feet of upper measures, containing two unimportant coal-seams, overlie it.

As a consequence of the great thickness of the Barren-measures—about 500 feet—and the absence of the coal which overlies the Pittsburg Coal, possibly that which attains such important thickness at Karthaus and other places to the N.E., the Freeport Limestone and Coal are the only beds of value found along the edges of this part of the basin we are describing. But as a heavy limestone mass has preserved the surface-land from excessive denudation, and left it comparatively level, we find that these beds are widely spread over the face of the country to the W. of the town of Indiana, being brought up by the third axis in all the creeks, where they afford the people an abundance both of fuel and lime.

Considering the axis of Chestnut Ridge as the most probable E. boundary of this basin, we may add that all along its line the lower coal-seams crop out. At Blairsville there are 2 seams of considerable size, each underlaid by a bed of limestone; and E. of that town the conglomerate begins to saddle the axis.

CHAPTER IV.

THE FOURTH BASIN AND ANTICLINAL AXIS.

A HIGH narrow range of mountains, deeply and frequently gashed, and similar in all respects to the two first described, stretches from the Tioga River W., between the anticlinal valleys of Wellsborough on the S. and the Cowanesque Creek upon the N. Composed at its base of the upper part of the Vergent rocks of the valleys—embracing higher on its sides the grey Vespertine sandstone and Umbral shales, the Ponent red rocks having nearly thinned out, and its summit capped here and there with larger or smaller patches of the Seral conglomerate—it rises from the rolling land of Bradford County, which it overlooks, 5 or 6 miles E. of the Tioga River. This stream flows transversely across it, and ranging away W. by S. along the N. side of Pine Creek, is finally lost in the general upland of S. Potter and McKean counties. There the coal-rocks, which to the E. are found in exceedingly small patches at the summits, occur more frequently, and after passing the Driftwood Branch of Sinnemahoning, become a continuous basin, growing regularly deeper towards the S.

It may be well to speak here of a topographical peculiarity of these projecting mountain terminations of the several basins towards the E., because the opportunity presents itself in the basin under consideration for, perhaps, its happiest illustration. Recognising the general law of water-courses, as descending from the centre lines and summits of mountain-ranges to the plain, the spectator is here surprised to see the various streamlets take their rise along the centres of the intervening valleys, and, flowing towards and into the mountain, there unite and divide it lengthwise; and when they finally flow away to the nearest river N. or S., seeking an exit by a separate gap. A glance at the map will exhibit this remarkable phenomenon, while its explanation will be afforded by reference to General Sections, Nos. IV. and VI., in which it may be seen that the waters take their rise along the line of axis in the valley, flow down the dip of the rocks toward the mountain, and collect in streams where the synclinal trough is deepest.

Thus is the mountain-range of the first basin furrowed lengthwise by the Mahoopeny and Loyalsock; that of the second, by the Middle Branch of Towanda Creek; the third, by the head-water of Tioga River; and more remarkably, the fourth and fifth by the branches of the Crooked Creek and Cowanesque. So with the first and second forks of Pine Creek, and waters further W. All these streams have the tendency to seek and flow along the middle of each basin, and leave it only when they seek their final exit into the lower country N. or S.

The course of the fourth axis, which crosses the Tioga River 2 or 3 miles N. of the State line, is easily traceable along the valley in which flow the tributaries of the Cowanesque; but after entering the wild upland at the heads of Pine Creek and the Alleghany, it becomes difficult to tell its exact position. An almost unbroken forest covers the greater part of Potter County, in which the indistinct indications of the very gentle dips that distinguish the last 3 basins universally conceal themselves. Crossing the Driftwood, 3 miles above Portage or Emporium, and perhaps 10 miles above Axis No. 3, the fourth axis ranges up the bed of West Creek, and brings to view, in the creek, the upper edge of the Vergent rocks and the Ponent red sandstone; while the Vespertine and Umbral series appear in the hill-sides, and to some extent overspread the face of the country above. Thence curving regularly to the S.W., between the Clarion River and the Little Toby, and ranging through the central parts of Elk County, it crosses the S. Branch of Sandy Lick Creek, 2½ miles E. of Port Barnett, Little Sandy Lick Creek, 3 miles from its junction with the Red Bank Creek, and the Mahoning, near the mouth of Glade Run. After passing the Cowanshannock, 7 miles E. of Kittanning, it crosses Crooked Creek, 3½ or 4 miles from the Alleghany River, and dies away upon the Kiskiminetas, 2½ miles from its mouth.

Along its whole course from Tioga River to the head-waters of Trout Run, with the exception of patches of Seral conglomerate, it is covered by the Umbral shales and sandstone rocks of the Vespertine series; but from the Little Toby Creek, towards the S., by an increasing thickness of Coal-measures.

The Coal-Measures.—But one bed of coal above the Seral conglomerate is found in this basin, E. of the Driftwood Branch, and that one only in small isolated patches along the central line, and at the tops of the highest hills. It is seen at one or two points on the Pine Creek waters in Tioga County, and on the Driftwood. At the former localities it is very thin, but increases in importance as we go W. On the Driftwood it measures 4½ feet in thickness, and is found 50 feet above the conglomerate.

After passing the Ridgway Turnpike the basin rapidly deepens, and contains, on the Little Toby and Brandy Camp creeks, six beds of coal, 3 of which display a thickness of 3 feet. Three beds of limestone accompany them in various localities.

At the Brookville Turnpike the lower beds arch over into the third basin last described, but continue to crop out towards the W. upon the flanks of the fourth axis. This is due to the shallowness of the basin, and its very gentle subsidence towards the S.W. The higher beds, those of the Freeport series, are not therefore found in it, until we pass S. of the Turnpike, when they assume their places in the centre of the trough; and as we continue to go S., they spread gradually over it, and at length arch over either axis into the basins to the E. and W. At this point the central line of the basin is occupied in turn by the higher unproductive measures.

At the crossing of the Turnpike on the E. Branch of Sandy Lick Creek, are 3 beds of coal and 2 beds of limestone. The uppermost bed here is a noble coal-seam 8 or 9 feet thick.

At Smicksburg, on the Mahoning, are found the Freeport upper and lower coal-seams, with their included limestone stratum, the upper coal-bed measuring 4½ feet in thickness. From the Mahoning S. to the Kiskiminetas these beds are the common ones of the basin, occurring at the level of most of the small streams, while the hills above are composed of unproductive higher measures.

CHAPTER V.

FIFTH BASIN AND ANTICLINAL AXIS.

A FIFTH synclinal range of mountain-land, similar in all respects to the preceding one, enters the State along the Northern line of Tioga County, bounded on the S. by the straight valley of the Fourth or Cowanesque Creek

axis. Its Northern limit, which enters the State at the extreme N.W. corner of Tioga County, is irregular, and is not traceable by a mountain escarpment. In New York State this range of Carboniferous strata terminates in the neighbourhood of the Tioga or Chemung River.—(See the New York Geological Map.) No Coal-measures have been discovered capping its conglomerate covering, until we approach Coudersport. The upper of the Vergent series sweeps from the valley of the Cowanesque Creek, around its termination in New York, and ranges along its Northern margin.

Its connection with the general table-land of Potter, McKean, Elk, and Forest counties, is accomplished without any abrupt change of topographical character; first, because of the increasing gentleness of the dip which marks the successive basins as we proceed N.; and next, by reason of the increasing agreement in structure between the rocks of the Vergent, and Vespertine and Umbral series, in the same direction. By the former the results effected by general denudation become less definite along the lines of the trough and anticlinal axis, the flexures disappearing in an almost universal horizontality. By the latter, the difference in amount of denudation upon the rocks of the valley and the rocks of the mountain grows smaller Northward, and forbids that boldness in the synclinal mountain escarpments here, which gives its clearest feature to the region of the basins further S.—(See General Section VI.) Thus the whole country is much elevated, and at the same time deeply and irregularly grooved by all the water-courses. In these, especially along the line of the fifth axis, the Vergent rocks are discovered; their upper edge being at a less or greater height above the water-level, while the chief portion of the country above is composed of the Vespertine sandstone and the Umbral formation, on which, between the streams, and generally along the middle of the basin, lies the massive stratum of the Seral conglomerate. This will better be described in connection with the coal.

The curve of the Fifth and last axis conforms, as far as it is known, with that of the axes to the S.E. of it, being difficult to trace with accuracy as to its summit-line, because of the extreme slightness of its dips both Northward and Southward. It enters Pennsylvania near the Genesee River, crosses Potato Creek near Smethport, bends Southwardly through the wilderness of McKean and Elk counties, crosses the Clarion River 5 miles below the mouth of Millstone Creek, and the Brookville Turnpike W. of the Old State Road between Kittanning and Olean, and entering the country W. of the Alleghany River, between the mouth of the Mahoning and that of Red Bank Creek, passes on between the heads of Deniston's and Limestone Runs, crosses Buffalo Creek 3 miles above Worthington, and dies out in a line 3 miles W. of that village.

From the entrance of this axis into the State, as far as to the Alleghany River near Smethport in McKean County, it is everywhere covered by the Vergent and Vespertine series, the limits of which, as distinct formations, have not yet been clearly defined. Thence Southward beyond the Clarion it supports the Seral conglomerate strata, arched in one or two places by the lowest coal. Where the deep and narrow valleys of the streams—and these are very numerous—have cut through the conglomerate, the rocks below it are exposed. At the Brookville Turnpike, the first great Seral sandstone above the conglomerate is for the first time clearly recognised arching the axis; and then successively follow, from this point Southward, the beds of the Clarion and the Freeport groups. The former throw their outcrops, one after the other, across the axis, between the Turnpike and the Alleghany River; the latter do the same beyond the river.

Coal Beds of the Fifth Basin.—The central line of the Fifth Basin passing about 5 miles to the N. of Coudersport, a single coal-bed is found in many localities above the Conglomerate, but it is of no great value. As we proceed Westward the measures are increased by the addition of the Tionesta sandstone, with several beds beneath it, and one or two of the coal-beds over it. This is the case on the highland on each side of Potato Creek, to the S. of Smethport, and a few miles still further W., where we have a number of coal-beds several feet thick, and a limestone stratum 15 feet thick.

The N.W. outcrop of the Coal-measures here coincides very nearly with the course of the Turnpike Road from Smethport to Ridgway, the Fifth axis bringing up the rocks of the Seral conglomerate N. of the Turnpike.

The Basin, as we follow it towards the S., deepens very little, if at all, and we have at Brookville the same beds as in its more Northern portion. At the tops of the highest hills, here and there, along the centre of the basin, even as far to the N.E. as Instantur, limestone is sometimes found, but nowhere as a valuable continuous

bed, until we descend the Red Bank Creek, where the basin rapidly deepens, and the whole of the Clarion group, with its top sandstone, the Freeport sandstone, becomes well developed. At Kittanning, the Tionesta sandstone has sunk below water-level, and at Freeport the whole Clarion group, its place being occupied by the group next above, or the Freeport group; while the bottom rocks of the still higher Barren group cap the hills.

In this more Southern part, the Fifth Basin is fruitful of coal and limestone. Along the Red Bank Creek and its tributaries, we everywhere meet with the Brookville, Clarion, and Kittanning coals, and the limestone of their series, the Ferriferous. The three coal-seams mentioned average 3 feet in thickness, and the limestone is always a useful bed, from 4 to 6 feet thick, frequently supporting a stratum of iron ore, much sought for, and often very valuable. These beds, as has been said above, arch over either axis into the Fourth and Sixth Basins, and therefore to the S. must be conceived of as spreading through the whole country, until they gradually sink below water-level. Upon the Alleghany River, below the mouth of the Mahoning Creek, the ferriferous limestone becomes a most important stratum, averaging for many miles full 15 feet in thickness, and sustaining generally a peculiar buhrstone ore upon its upper surface. The latter is often 1, 2, and even 5 feet thick, as at Alleghany Furnace. Between Freeport and Kittanning, however, these valuable rocks sink together gradually below the bed of the river and the general water-level of the middle of the basin, and the thinner limestone of the Freeport group next above descends with equal gradations from the highland, and takes its place, accompanied by the upper and lower Freeport coal-beds, each averaging in thickness about 3 feet. These are the common beds of the country to the E. and W. of Freeport, and their outcrops in the Sixth Basin will be traced as they stretch through it into the State of Ohio. The Elk Lick bed of coal, which we have reason to believe much more irregular than any of the rest, is poorly represented in this basin, and is only once found to be workable. This locality is upon Crooked Creek.

The lowest or Tionesta group is also poorly developed in the S.W. part of the Fifth basin, being destitute of limestone, and generally with but one coal-bed, and that of very moderate size.

CHAPTER VI.

THE SIXTH COAL-BASIN AND FINAL OUTCROP OF THE NORTH-WEST.

A LINE drawn in a W.S.W. direction from Kenzua on the Alleghany River, near the Western county-line of McKean, through Sandy Lake, Mercer County, to Youngstown, on the Mahoning River, in the State of Ohio, will define with tolerable accuracy the North-western limit or outcrop of the lowest coal in this Sixth and last basin of the great Bituminous Coal region. This outcrop is, however, by no means a straight line; for every valley along this boundary-line, and for many miles inward to the S.S.E., cuts necessarily down through the coal, and develops the lower rocks, even far down into the Vergent series. Thus every intermediate high hill or patch of table-land becomes an isolated coal-field, less or greater in area, according to circumstances, dependent upon the amount of local denudation.

Beyond this line, North-westwardly, none of the Coal-measures above the Seral conglomerate extend; but the conglomerate itself, in an irregular band, ranging parallel to the line, caps all the land between the valleys, and presents in its turn an escarpment towards Lake Erie, along a line drawn parallel to, and at an average distance of 10 miles from that above given. The Vergent strata issue from beneath the conglomerate, and occupy in a succession of terraces the rest of the distance to the shore of the Lake; while the absence of the Vespertine and Umbral series is accounted for by the complete thinning-away of those strata or by their coalition with the upper Vergent rocks, so as to be quite indistinguishable lithologically from them.

Beneath the Conglomerate we find, in place of a well-defined Vespertine stratum, a small group of Coal-measures, which will be presently described, and an analogy drawn between them and a series holding a similar position in the extreme Southern part of the State.

It only remains to add, that outside of the band of conglomerate mentioned above, there occur here and there, upon the very highest grounds, several small outlying patches of that rock which have resisted the general denuding force which has elsewhere laid bare the upper surface of the lower rocks. One such, for instance, may be found upon the State line of New York, in the N.W. corner of Warren County, and several others around Meadville. The shape and size of these in their superficial area can only be usefully known by a reference to the Map.

Coal-Measures of the Sixth Basin, Tionesta Group.—Commencing our description of the Coal-measures of the Sixth Basin at the N.E. end, as usual, it may be remarked, that from the Genesee River to the Tunamaguont * Creek the country between the water-courses is everywhere overspread by the Seral conglomerate, no coal being seen, with the exception of one small seam below the conglomerate, until we reach the head-waters of the latter stream. Most of the valleys expose the conglomerate; the underlying sandstones and shales, with their included limestone beds, are all of carboniferous age, and the deep red slates probably of the Ponent and Vergent sandstones, here perhaps 100 feet in thickness, often occur at the water-level.

The first coal-beds above the conglomerate make their appearance on the head-waters of the Tunamaguont, and at the nearest point about 5 miles to the W. of Smethport. An outlying patch about 4 miles long, and 1½ miles wide, is seen between the branches of Sugar Creek to the E. of Kenzua village, and several smaller areas occur still further E. towards Tunamaguont. About 4 miles W. of Kenzua, on the opposite side of the Alleghany River, occurs a very small patch of the same; and there is an extensive area of it along the N.E. side, and between the main forks of Kenzua Creek and the head-waters of the Clarion River.

From the line of Kenzua Creek S.W., the area of the coal becomes, so to speak, continuous, because only intersected by the very numerous ravines of denudation. A little S. of the mouth of Tidioute Creek its N. edge crosses the Alleghany River, and thence to Oil and French creeks, it occupies seven larger patches of table-land between the larger creeks. Its limit to the S.E. is parallel to, and 2 or 3 miles distant from, the crest of the fifth anticlinal axis, until that axis strikes the Clarion, where this group of strata arches over it, and runs back in the basin last described towards the N.E.

Over all this country, to the E. of the Alleghany River, and as far down towards Kittanning as they have been found, being occasionally brought to view by the axes, the two or three coal-beds of this group are unimportant seams, seldom exceeding 1½ or 2 feet in thickness, and being generally poor in quality. They occur to the N.E., within a mass of shales, from 40 to 60 feet in thickness, over which is spread the great Tionesta sandstone of nearly equal bulk. This sandstone stratum forms the surface of every plateau between two streams, as far as the Clarion River. There it begins itself to be covered in turn by the rocks of the Clarion series.

West of the Alleghany River and French Creek, a great change is observable in the rocks between the conglomerate and the Tionesta sandstone. This change attains its maximum in the neighbourhood of Mercer, where we find the interval to reach 100 feet, and to contain four coal-beds, the upper one, the Tionesta Coal, being 6 feet thick, and the other three averaging 1½ feet in thickness, with a limestone bed (the Mercer Limestone) sometimes 4 feet thick. Still further to the S.W., and in the neighbourhood of Newcastle, on Beaver River, another limestone bed (the Mahoning Limestone), 2 feet thick, is interposed immediately under the Tionesta sandstone; while the Tionesta Coal-measures have there resumed their former insignificance as productive strata.

Sharon Group.—In the neighbourhood of Sugar Lake, 10 or 12 miles N.W. of the town of Franklin, a series of rocks, resembling the Coal-measures, makes its appearance beneath the main body of the Seral conglomerate. This group of coal-strata is not to be considered as a lower coal-formation, but as merely a part of the lower group of the Coal-measures, locally developed by increase of the coal-beds, and a proportionate reduction of the pebbly matter of the sandstones. Becoming better developed as we trace it N., it is found to consist usually of a single coal-bed from 12 to 20 feet below the base of the conglomerate, generally quite thin and poor, but attaining, in the neighbourhoods of Georgetown and Sharon, the thickness of 5 feet.

At intervals of 15 and 20 feet below this bed, are found in one locality, 6 miles N.W. of Mercer, two other coal-beds, 1¼ and 2½ feet thick respectively. At Georgetown, valuable iron-ore overlies the bed first described.

* Sometimes Tunuangwant; but we spell here as in the "Gazetteer of the United States."

Small as this coal-seam generally is, it is known to extend to a great distance, as it has not only been found to the N., at Meadville, and to the S. at Lawrenceburg, but as far down the Alleghany River as the mouth of the Mahoning Creek, where it is represented by three very small seams, each only a few inches thick.

Clarion Group.—The base of this group of coal-bearing strata, which measures in many places 175 feet, though in one district it is said to be 98 feet, is the Tionesta sandstone, a coarse grey or yellowish rock, sometimes much blotched, and streaked with peroxide of iron, and overspreading, as mentioned above, all the N.E. part of the Sixth Basin. In the higher hills about Lafayette, and at the head-waters of the Kenzua, it is capped by a body of coal-bearing strata, including, in some places, five or six distinct seams of coal. We have not followed the basin critically through the wilderness of Forest County; but the rolling character of the trough itself, when so immensely expanded, does not favour increased thickness of coal-strata within it going S.W. Thus, as far S.W. as Racoon Creek, in Venango County, we find knolls and small ridges, containing only one or two beds of coal, above the Tionesta sandstone (the Brookville and Clarion coals), which sometimes have their summits covered with fragments of the next superior bed of limestone, the Ferriferous limestone. These, however, soon become continuous beds, and are overlaid by the Kittanning Coal-bed in Richland and Beaver Creek townships. The outcrop of this latter bed is far more irregular than usual, and more difficult to trace, because, instead of being protected by a hard stratum of sandstone, it supports, and is supported by, many feet of soft argillaceous shales, affording little or no resistance to the denudation, which, in acting readily upon the shales, has also swept away the included coal. This is the case along its N. and N.W. outcrop, where the Freeport sandstone, which is the upper limit of this group, is separated from the coal by many feet of such shales.

Outcrops.—In tracing the outcrops of the coal-beds in the Sixth Basin, it should be noticed as preliminary, that the two counter-dips of the basin are very unequal in length. The dip from the N.W. is not more than one-seventh of a degree; while that from the axis towards the N.W. diverges 2°. Hence the geological centre-line of the basin or synclinal axis ranges parallel with the fifth axis not more than 5 miles distant. It is in this line, of course, that the beds have their greatest N.E. prolongation.

The Brookville Coal.—This bed, lying immediately upon, or a few feet above, the Tionesta sandstone, has an irregular outcrop, coinciding in the main with that of the Clarion coal and Ferriferous limestone above it, and it will be best described with theirs. To the N.E. and E. this coal is a large and useful bed; but it dwindles away, and almost disappears when traced W. towards the Ohio River. In Rockland township, S.E. of the town of Franklin, it is divided into four beds about 2 feet apart, the lowest measuring 5 feet, and the whole containing 7½ feet of coal. This is indeed an unusual thickness for this coal-seam, and only a few miles off it consists of three seams, which are in all but 2 feet thick. Its average thickness along the fifth axis and the Clarion River may be considered to be 4 feet. Further down the Alleghany River, and on the Kiskiminetas it seldom exceeds 1 foot, and upon the Ohio River, and in the neighbourhood of Beaver, it is found varying from 2 to 6 inches in thickness; while higher up the Beaver, as at Newcastle, it again assumes a thickness of 3 and 4 feet.

Clarion Coal and Ferriferous Limestone.—The extreme N.E. limit of the uppermost of these beds, the limestone, is, as far as known, just within the line of Forest County north of the Clarion River. Although a section of the strata in M'Kean County represents coal-beds certainly higher in the series than this limestone, no trace of it is yet discovered.

The Clarion Coal-bed, which is about 15 feet under it, occurs in patches somewhat beyond the limit of limestone above indicated. But by drawing a line through the outermost patches of the limestone, the outcrop of the Clarion Coal-bed will also be determined. Such a line will cross the fifth axis, near the Brookville and Franklin turnpike; thence curving, to range nearly parallel with and about 2½ miles from the axis, it will cross the Clarion, and sweep round close by the S. head-waters of Racoon Creek towards Franklin, until it reaches Pine Creek, a branch of Six-mile Run. Here it will bend to the S.W., cross the Alleghany a mile below the bend at Scrubgrass Creek, and thence pass due W. to within 5 miles of Mercer. There it turns to the S., crosses Hart's Run 3 miles from its mouth, and ranges down to the mouth of the Little Neshannock, and so down the W. side of the Neshannock Creek to Newcastle. As it merely touches on the high ridge S. of New Bedford, its outcrop may be said to enter the State of Ohio south of the Mahoning.

In thus tracing the outcrop of the Clarion group of coal-beds, we have left out of consideration the Coal-measures based upon the Tionesta Sandstone, in M'Kean County, because the limit of those seams is very imperfectly known, and there is difficulty in a satisfactory correlation of the strata.

The Clarion Coal-bed exhibits a variation in thickness similar to that of the Brookville Coal, but the direction in which this difference increases is nearly opposite. This bed thickens to the S.W. as that one does to the E.; but in neither case is much regularity in increase or decrease to be reckoned upon. It is scarcely 1 foot thick anywhere along the Clarion and Red-Bank, in the neighbourhood of the fifth axis; but as we go W., it increases in thickness. At Shippenville it is 2½ feet; on Rocklar Creek, 3½ feet; and in the N.W. corner of Butler County, in one locality, it is 6 feet thick. On the Beaver River its average thickness is about 2½ feet. —(See the Sections).

In the N. townships of Butler County, and in Scrubgrass and Irwin townships of Venango County, the 30 or 40 feet of brown shale which separate this coal-bed from the Brookville coal below it are the chief repository of the nodular iron-ore made use of in that part of the country.

The Ferriferous limestone is so called because, in many localities, such as the Deal Bank, near Shippenville, on Point Creek, and at the furnaces W. and S. of Kittanning, a very valuable deposit of iron ore rests directly upon it, while in other localities the bed of limestone itself seems to be divided between carbonate of lime and carbonate of iron. This ore is accompanied by a species of chert called "The Buhr-stone," which, as seen on Point Creek, is compact in its texture, externally grey, but light blue where newly fractured, and usually interposed between the limestone and the ore. The latter is variable in its character, sometimes a solid hard blue fossiliferous stratum like limestone, again consisting of crusts or shells, which contain cavities and perfectly-formed nuclei. It varies in thickness from 6 inches to as many feet.

This limestone band, which apparently has its N.E. limit along the Susquehanna and Sinnemahoning waters, although its Eastern point has not with certainty been fixed, retains, nearly to the Alleghany River, a very uniform character, and a thickness seldom exceeding 4 feet. As it approaches this stream it increases in size, being 10 feet in thickness at Franklin, and 15 feet at Kittanning. On the Beaver River, still further to the W., it is 12 feet thick, and 20 feet at its point of subsidence, beneath the water-level of the Ohio River. It is usually a blue carbonate of lime of compact structure; but it is often of a grey-blue colour, hard and solid, with a few fossils, Atrypa, Encrini, and Terebratulæ. Sometimes, as in the Sandy Lake township, S.W. of Franklin, it is even divided into two beds by more than 12 inches of clay, and a few inches of coal.

The Scrubgrass Coal-bed.—Underneath this limestone bed, at several localities, in the country lying between Newcastle and Franklin, a small coal-bed makes its appearance, worthy perhaps of notice in this summary, although its maximum thickness is but 20 inches. At Newcastle the limestone lies immediately upon it; elsewhere, a few feet of other strata intervene.

In the basins to the S.E., the first coal-bed over the ferriferous limestone is the ferriferous coal; but in the country we are now describing, that bed is never found. The next in order, therefore, is the

Kittanning Coal-bed.—This coal-seam lies generally about 30 feet above the ferriferous limestone; but sometimes the interval amounts to 67 feet, as on Beaver River, and even to 80 feet, as on the Clarion. Throughout this basin it is everywhere very uniform, averaging 3 feet in thickness, seldom becoming less than 2 feet, and never more than 4 feet thick. Upon the Clarion, W. of Brookville, however, it suffers a local diminution, which reduces it to a thickness of a few inches.

Its outcrop crosses the Fifth Axis, between the head-waters of Leatherwood Creek and Licking Creek, passes on N. and N.E., parallel to and close by the axis, bends round sharply near Roseburg, skirts the Clarion Valley, which it crosses at the mouth of Deer Point Creek, proceeds thence N. to Shippenville, and then turns and crosses the Alleghany 3 or 4 miles above the mouth of the Clarion. It then ascends the W. side of the Alleghany River for a short distance, takes a Westerly course, parallel to, and about 7½ miles N. of the Butler and Venango County line, and closely approximates the outcrop of the ferriferous limestone-band, before described, upon the Neshannock Creek. The outcrop of the coal-bed, however, keeps off again, down the S.E. side of the Neshannock Valley, and crossing the Beaver River at the mouth of the Mahoning, strikes off due W. into the State of Ohio.

The Freeport Sandstone.—This second great Coal-measure sandstone—the base of which on Red Bank Creek, is 75 feet above the Kittanning Coal last described, and the top of which, opposite the mouth of Red Bank Creek, immediately underlies the Freeport Coal, next to be described—is by no means an invariable component of the Coal-measures. Although spread out as a persistent member of the great series over a vast extent of country, from Somerset County to the S.,* and beyond the Alleghany River to the W., to the extreme N.E. limits of the Third Basin, where it seems to have had an agency in preserving from more extensive denudation the coal of the Blossburg field, we find it frequently degenerating locally into shaly sandstone, more or less coarse, or even into shale of only a few feet thickness. This is especially the case toward the N.W. limit of this sixth basin.

The Freeport Group.—The outcrop of the lower Freeport Coal-bed enters the sixth basin over the fifth axis, at a point a mile or two W. of Worthington, 7 miles from Kittanning, and ranges along the W. side of the axis to the mouth of Red Bank Creek. Reaching Licking Creek, it recurves, and again crosses the Alleghany River 3 miles below Lawrenceburg. Thus a portion of the area covered by this coal-bed is prolonged across the Alleghany River, but it is of trivial dimensions, not exceeding in its widest part 7 miles in breadth, nor nine miles in its entire length, and holding also within these narrow limits the still smaller concentric areas of the two superior beds of limestone and of coal that will next come in order for description. From the W. side of the Alleghany River, the outcrop of the lower Freeport Coal-bed takes a W. by N. course to the Butler and Scrubgrass Road. Here it turns slightly more N.W., and trends in a very straight line to a point upon the Beaver River, 2½ miles N. of the mouth of the Conequenessing Creek, and thence to Fairfield in Ohio.

The outcrops of the Freeport limestone and upper Freeport coal, nearly coincident, cross the fifth axis at a point 7 or 8 miles to the S.W. of that at which the outcrop of the coal-bed last described crosses it—a parallelism which they generally maintain. Stretching first N.E., they cross the Alleghany close above the influx of the Red Bank Creek; they enclose, as has been said, a small area on the E. side of that river, and recross it at the bend, 2½ miles above Catfish Creek. Still keeping a direction parallel with that observed by the outcrop of the coal below, and projected somewhat N. near the Butler and Scrubgrass Creek Road, they cross the Beaver River four miles below the mouth of Conequenessing Creek, bend N. up to Greensburg, and then make their escape W. into Ohio.

While the interval between the upper and lower Freeport Coal-beds varies incessantly, that between the Limestone Band and the Upper Coal preserves great uniformity. In the region under notice, the limestone is everywhere found within 10 feet of the bottom of the coal. Often, as at Old Brighton, and below it on the Beaver River, 2 or 3 feet of fire-clay is all that intervenes. The thickness of interposed rocks between the limestone and the lower coal at the extreme N.E. end of the area—that is, on the Alleghany River—occupied by these beds, is about 40 feet, but it increases as we follow them towards the Ohio. On the Beaver River, 70 feet of brown shales occur between them; below Kittanning the interval is equally great. At Butler, and towards the State of Ohio, upon the Ohio River, there is an interval of 75 feet.

The Lower Freeport Coal.—This bed is generally small. If its average thickness over the whole region were estimated, it would scarcely exceed 1½ feet. Occasionally, however, it assumes an importance which elsewhere does not belong to it. At Beaver River, on a fork of Trough Run, it measures 4 feet 3 inches of semi-cannel coal; and three miles above the mouth of the Connequenessing, its thickness is fully 6 feet. In the neighbourhood of Worthington it lies immediately upon the Freeport sandstone, the basis of the series, and is separated from the Kittanning coal below by about 50 feet of strata. Upon the Alleghany River the same interval is increased to 135 feet; while on Tomlinson's Run, in Ohio, it is only 23 feet—the coal itself measuring from 4 to 6 inches.

The Freeport Limestone.—This widely-extended bed averages a little more than 3 feet in thickness, though from Kittanning downwards along the river it increases from 5 and 6 to even 10 feet. It is usually of a light-blue or dove colour, and is often fine-grained and homogeneous. In the neighbourhood of Butler, and

* See Conglomerate-band above the coals in the Castleman River section and the Indian Creek section.

below New Brighton, it occurs as a bed of nodules; but it still retains its usual thickness of three feet. This is its character also beyond the Ohio State line.

Upper Freeport Coal.—This is an extremely variable bed of coal, being, as to this characteristic, the reverse of its companion, the limestone. On Beaver River it is often reduced to a mere trace a few inches thick, and then again it suddenly expands to a workable size, and becomes a useful bed of coal. Along the central line of the sixth basin it is often more than 4 feet thick, but it is never found to retain a given thickness for any great distance. Its coal is generally excellent.

The Barren Group.—Above the upper Freeport coal-bed lies a mass of sandstone of a homogeneous character towards the Beaver River country, but becoming a true conglomerate along the Mahoning Creeks. It may be a question for the curious, how far the variableness in thickness of the upper Freeport coal-bed may be attributable to the agencies concerned in making this deposit. This is the Mahoning Sandstone.

From Butler S.W. we fall in with yet higher measures: these increase in depth of material in that direction, in obedience to the regular slope of the basin. Above the small seam representing the Elk Lick Coal-bed are shales and slaty sandstones; after passing Thorn Creek, yellow and greenish shales are seen to rest upon the latter. This is the red and variegated band which spreads so widely over the whole bituminous coal-field along the central lines of all the basins, wherever the land is high enough to take them in. At Pittsburg these have sunk nearly to the water-level. The gentle undulation of the fifth axis has caused their denudation along it; but they occur again in the fifth basin, about 7 miles W. of Freeport, and stretch past Kittanning. Being soft and friable, they decompose into a clay, and often contain small nodules of limestone.

Upon the series of rocks last mentioned, and immediately overlying a variable seam of hard brilliant coal, from a few inches to a foot and a half thick, there is a thin, sandy, ferruginous, blue or brown limestone, abounding in fossils, and ranging widely through the basins. It occurs at Kittanning, everywhere on the Kiskiminetas and Mahoning creeks, where the basins are deep enough to receive it along their central lines, and is traceable as far N.E. as Clearfield Creek: in the latter neighbourhoods, however, the coal is wanting. At Karthaus, on the contrary, the coal seems to be present, and the limestone wanting. This limestone is found in most of the hills around Woodville, and may be seen upon the turnpike running S. from Butler, about half a mile from the bridge, and perhaps 50 feet from the summit of the hill. As the basin deepens toward the S.W., this bed occupies of course a wider area and a lower position upon the hill-sides: it is usually 1 or 2 feet in thickness, and above it are olive and blue slates.

The rest of the Barren Measures.—We have now arrived at that line or belt of outcrop which, as will appear by glancing at the map, divides the great bituminous field, with all its basins, E. and W., by a zone of land barren in coals, into two nearly equal parts. Before passing this zone to the S., and carrying on the description of the whole series of Coal-measures in its next subdivision, based upon the Pittsburg Coal-bed, to the S. line of the State, it will be proper to take advantage of the opportunity afforded to bring up the description of the first and second basins in their prolongations S. of the Conemaugh River.

SUBDIVISION II.

BITUMINOUS COAL-BASINS SOUTH OF THE CONEMAUGH AND OHIO.

THE two most prominent features of the country S. of the Conemaugh River are the two anticlinal mountain ranges, Laurel Hill and Chestnut Ridge, the supposed prolongations S. of the highlands elevated by the first and second axis described in the preceding pages. Bringing up along their summits the Vespertine Sandstone, and supporting on their broad flanks the outcropping Lower Coal-measures, which N. of the Conemaugh arch over them, these two lines of elevation make the region susceptible of a threefold division, of which each

part shall be considered in detail. The country between the Alleghany Mountain and Laurel Hill will be the first division: it is subdivided into three subordinate basins. The second division lies between the great mountain axes. The third stretches from the Chestnut Ridge to the W. line of the State: this also includes several subordinate basins.

CHAPTER I.

THE FIRST COAL-BASIN AND ITS SUBDIVISIONS, OR THE SYNCLINAL BELT BETWEEN THE ALLEGHANY MOUNTAIN AND LAUREL HILL.

THIS wide tract of Coal-measures, descending from the W. summit of the Alleghany Mountain, and ascending the E. slope of Laurel Hill, is traversed lengthwise by two subordinate lines of anticlinal elevation. The first, which is the axis of Negro Mountain, issues from the State of Maryland, between the head-waters of Jones's Run and the waters of the Little Youghiogheny River, crosses Castleman's River below the mouth of Buffalo Lick Creek and Shade Creek, between Huskin's Run and Roaring Fork, and expires on the summit of the Alleghany Mountain, S. of the Portage Railroad. At this its Northern termination it is merely a broad and gentle swell or roll of the rocks; but retracing it S., we find it assuming a more decided character. It forms a line of hills, increasing in height as they pass within 2 or 3 miles of Stoyestown to the E., and at length becomes in Negro Mountain a bold and regular ridge. This, as the axis continues to rise gradually Southwards, parts at the State line into two slowly-diverging mountain-ranges, which continue their course towards the Potomac River.

The second sub-axis of this basin issues S. from the imperfectly explored country around Ebensburg, crosses the Conemaugh at the Railroad Viaduct, 8 miles E. of Johnstown, where it brings up the red shales of the Umbral series; thence ranges to Stony Creek, below the mouth of Paint Creek, and is last observed upon the Quemahoning, at the mouth of Roaring Run. In the general aspect of the country this sub-axis scarcely makes its presence known, except perhaps by a line of hills rather higher than the crests of those on either side of it.

Thus we have in the first basin, S. of the Conemaugh, three minor troughs; the Salisbury Trough to the S.E., the Johnstown Trough to the N.W., and the Stoyestown and Somerset Trough between the two. The Coal-measures along the whole course of the viaduct sub-axis, and along the line of the Negro Mountain sub-axis, as far S. as Somerset, pass over from one of these troughs to the other.

The First or Salisbury Subdivision.—In obedience to a general law in the conditions governing the undulations of the crust, while the sub-axis of Negro Mountain rises towards the S., the synclinal trough included between it and the Alleghany Mountain deepens in that direction. Hence the thickness of the Coal-measures at this N. end is inconsiderable, but increases rapidly Southward: at the head-waters of Stony Creek four coal-beds, as yet very little explored, give evidence of their existence throughout the neighbourhood, and three occur around Shanksville. The strata in the Alleghany Mountain generally dip to the W., at an angle varying from 15° to 20°, causing the overlying Coal-measures to ascend the W. slope to within 1½ miles of the E. crest. —(See General Section IX.)

Passing S. of Berlin the Coal-measures increase their total depth in the basin, and become at the mouth of Elk Lick Creek of sufficient thickness, not only to include all the barren measures above the Elk Lick Coal, but to take in also the Pittsburg Seam, with two other coal-beds, and a large limestone bed of the much higher Waynesburg series. The area of these is at first confined to a long and narrow strip of high land between Castleman's River and Elk Lick Creek, where they are parallel, and both run N. This strip of high land is here the central line of the sub-basin. By means of a salt boring on Elk Lick Creek, a section is obtained, which exhibits 400 feet of Coal-measures below the level of the creek; and the hill above described, capped by the limestone, furnishes about as much above.—(See Sections at Elk Lick Creek and Elk Lick Salt Well.) The

lower measures outcrop in a range of hills along each side of the basin, on the flanks of Negro Mountain and the Alleghany Mountain.

Of the Clarion group, three beds, one 3 feet, another 6 feet, and a third 3 feet 3 inches in thickness, are traceable here. The lowest and smallest one is either the Clarion or Brookville Coal. The next is the Ferriferous Coal-bed, underlaid by its limestone, 5 feet thick. This limestone is well developed at the mouth of Buffalo Lick Creek, overlaid by its appropriate ore-stratum, 2 feet in thickness. The third, 25 feet above the last, is the Kittanning Coal. Separated by an interval of 160 feet from the Ferriferous Coal below, we find, ascending to the Freeport group, the Freeport limestone, 5 feet, and Upper Freeport Coal, 2 feet thick. In the upper part of this interval, from 20 to 30 feet below the limestone, is the Lower Freeport Coal-bed. 50 feet above the limestone is the Elk Lick Creek Coal-bed,—here, as everywhere along the S.E. Barrens, a bed of considerable size, being 4 feet thick, and having sometimes, 10 feet underneath it, a nameless 1-foot bed of coal.

More than 150 feet of barren measures intervene between the Elk Lick and Pittsburg Coal-beds. In this group of barren measures occur two very small coal-beds, and a limestone above the uppermost 1½ feet thick.

Above the Pittsburg Coal-Seam, at intervals of 40 and 50 feet, are the outcrops of two coal-beds belonging to the Waynesburg group, and named after the places where they attain their maximum persistent thickness, the Sewickley and the Uniontown Coal-beds. Their exact thickness here is unknown, but the lower one is judged from the aspect of its outcrop to be a large seam: both occupy an area more confined than that covered by the Pittsburg Seam below them, their N. limit being in the narrow ridge before described, between Elk Lick Creek and Castleman's River. The top of this ridge is capped by a massive bed of limestone. These are the highest rocks in this first sub-basin, and are traceable S. in connection with the Pittsburg Seam into Maryland.

The iron ore over the Ferriferous Coal-bed is finely exposed at the falls on Elk Lick Creek. It here appears in three layers, the lowest affording 16 inches of solid ore. It makes its appearance also on other branches of the same creek; and is the same ore-stratum that is wrought in the second basin at Fayette Furnace, Ligonier Valley, and appears on Four-mile Run. It may also be hereafter identified with the abundant deposit of ore discovered on Shade Creek towards Johnstown, 10 or 15 feet beneath a 16-inch coal-seam, the Kittanning (?) Coal; and also at Lambert's Mill, where the ore is more disseminated in a bed of dark shale overlying a 3½ feet coal-bed, doubtless the Ferriferous Coal, with its limestone underneath, 2 feet in thickness.

The Second or Stoyestown Subdivision.—This subdivision of the first basin ranges N. into the Mount Pleasant and Philipsburg Coal-field, and at the S. unites, by the dying-out of the viaduct axis, with the third or Johnstown subdivision, in the latitude of Somerset.

Along the Conemaugh, which crosses it obliquely, its rocks are frequently exposed in perpendicular escarpments, affording fine vertical sections. At and near the summit of the Portage Railroad, the Clarion and Freeport groups of coal strata are developed, their E. outcrops ranging along the summit of the Alleghany Mountain. Three or perhaps four workable seams are among them, ranging from 2 to 5 feet in thickness. The Freeport limestone appears, and probably the Ferriferous limestone may also be found. A coal-seam of the Tionesta group has been recognised in a 9-inch bed, 10 feet above the conglomerate. It is to be understood that the names affixed to the several strata of coal and limestone are not the results of absolute identification of the beds, but are only to be regarded as the nearest approximations that can be made in the present state of development.

The limestones exposed on the Conemaugh vary in thickness from 3 to 10 feet, and at Johnstown the Ferriferous limestone is in part a cement, or hydraulic limestone. Higher in the hills at Johnstown two other bands of limestone occur, immediately below the uppermost of which reposes the valuable stratum of calcareous iron-ore so extensively mined at that place.

The representative of the Kittanning Coal seems to be small in this region, frequently not measuring more than 9 inches.

Besides the two small known beds of limestone there seems to be a third calcareous stratum, from 3 to 6 feet thick, claiming a position beneath the Lower Freeport Coal. It makes its appearance in two localities on Stony Creek—viz. at the Red Bridge and 5 miles S.E. of Johnstown. On Stony Creek, half a mile below the

Red Bridge, a limestone bed and bed of iron ore are observed together, 30 feet above the Ferriferous coal; an ore-stratum also exists on the old planes Nos. 2 and 3. The relation of these to the other beds of the series is at present so vague as not to warrant any strong assertion: each should be made a matter of further investigation.

Along the central parts of the trough two coal-seams occur in the barren measures below the Pittsburg Coal-beds. One of these was found to be 1½ feet thick.

Tracing this second subdivision of the first basin S. from the Conemaugh, there appears but little change in the series of rocks. Regarding the double seam of the Alleghany summit as one coal-bed, subdivided by an unusual thickness of shale, we find the vertical distance between the lowest coal-beds increases from 80 (?) feet to 100 at Stoyestown, and 130 feet at Salisbury. The Lower Freeport Coal is mined 4 feet thick at Stoyestown. The Upper Freeport Coal seems here to present the unusual aspect of two beds, each 3 feet thick, and 8 feet asunder: 90 feet above it is seen the outcrop of the Elk Lick Coal; and between that and the tops of the highest hills are two or three small seams.

By the rapid rise of the Negro Mountain axis, this middle trough is made so shallow, in approaching Somerset, as to contain but little coal in the neighbourhood of that town.

The Third or Johnstown Subdivision.—The series of rocks given above is substantially valid for the Western Subdivision of the first basin, along the E. flank of Laurel Hill and in the neighbourhood of Johnstown. Upon the summit of the mountain the Umbral red shales appear, while on its flanks repose the strata of the Seral conglomerate dipping rarely more than 7°.—(See General Section No. IX.) Between these two formations is the position for the Sharon Coal Group, first seen in the neighbourhood of the Stoyestown Turnpike, where it crosses Laurel Hill. Here the group is about 30 feet thick, and contains one bed of solid coal 9 inches thick, immediately underlying the conglomerate, as in the Sixth Basin. Traced 10 or 15 miles further towards the S., this bed becomes 2½ feet thick, and overlies the Umbral ore by an interval of 30 feet. This group continues to exhibit increasing thickness and richness of mineral contents in this direction until it disappears across the line into Virginia.

The Seral conglomerate along the E. flank of Laurel Hill is very variable. Upon the Conemaugh it is a coarse sandstone about 60 feet in depth; while W. of Somerset it shows but 30 feet. It, however, increases to upwards of 100 feet upon the Youghiogheny River.

Upon this conglomerate reposes, in all the country S. of the Conemaugh, a mass of sandstone strata, Tionesta Sandstone, &c., varying in thickness, character, and consistency, but always strongly marking the position of the lower Clarion Coal-measures, not merely geologically, but topographically also, by lines of high, steep, broken hills ranging along the base or flanks of the two anticlinal mountains, Laurel Hill and Chestnut Ridge. These hills will be described more in detail when we reach the first sub-basin of the country W. of Chestnut Ridge.

Shut up between these massive sandstone layers are the coal-beds of the Clarion and Freeport Groups. The Tionesta Group, on the contrary, seems to have representatives among them; and, as was before remarked in describing the Alleghany summit section, one of the coal-beds has thinned away so as to be barely noticeable.

The lowermost coal-bed, whether receiving the name of Brookville Coal or Clarion Coal, is at the Portage Railroad 5 feet thick, and at Johnstown 3½ feet, becoming thinner towards the S. We have seen it to be 3 feet thick in the S. part of the Salisbury subdivision, but on the W. side of Negro Mountain, along Castleman's River, it is but about 2 feet, and where it rises upon the side of Laurel Hill it varies from 3½ feet even down to 1 foot.

The Ferriferous coal-bed is the next above; it is divided from the preceding bed by an interval of about 70 feet, part of which consists of a massive stratum of brown sandstone, which in the Second Basin will be seen to become almost indistinguishable from the Seral conglomerate below. The Ferriferous limestone is present also underlying the coal. On Ben's Creek their respective thicknesses are, limestone 3 feet, coal 4 feet. But so variable are they in this respect, that at Milford their dimensions are, limestone 4 feet thick, and coal 1 foot; and on Castleman's River, limestone 8 feet, and coal 4 feet. Besides this, the character of the limestone does not persist, becoming, as a striking instance, in the distance of a few yards along the Johnstown and Somerset Turnpike, a bed of carbonate of iron.

The Kittanning coal-bed apparently maintains a uniform distance of 25 feet above the last throughout the

first and second subdivisions of the First Basin with considerable regularity, being 25 feet above it on the E. flank of Negro Mountain, and 30 feet above it along Castleman's River, W. of that ridge. Disregarding the Johnstown section, where the facts seem at variance with our observations at other localities, we find that along Laurel Hill the interval between the beds averages 50 feet. The rocks of this interval have everywhere a decided tendency to a shaly structure; and at the lowest limit of this shaly mass is to be found the iron ore which accompanies the Ferriferous Coal. The Kittanning Coal-bed, which appears as a very thin seam at Johnstown, exhibits an increased thickness of 4 feet at many places along the E. flank of Laurel Hill, but towards Negro Mountain, on Castleman's River, it is again but 2½ feet thick.

The Lower Freeport Coal maintains a thickness of 4 feet along Laurel Hill Creek; but on Castleman's River it could nowhere be recognised. It seems to thin out locally in that direction, since in the Salisbury Section (See Column, Chapter XXIX.) it is only marked, if at all, by a thin seam 25 feet beneath the Freeport Limestone.

Along the Conemaugh and Laurel Hill Creek this bed lies at a distance of 20 or 30 feet above the Kittanning Coal (See Column, Chapter XXIX.), and is shut in by massive sandstone strata, the representatives of the Freeport Sandstone. This divisional rock appears, however, throughout this region rather to be above than below the Lower Freeport Coal-bed. The abundance of sandstone between the Kittanning and Upper Freeport Coal-beds is very manifest, and may in part explain the imperfect exposure, or perhaps the actual thinness, of the included Lower Freeport Coal-bed, at the S.E. portion of this First Basin. Where the interval is small, the latter bed appears as along the Laurel Hill; but where the interval is great (105 feet in the Salisbury Subdivision of the First Basin, and 100 feet in the Second Basin), on either side of this central line the coal-bed escapes observation.

The Freeport Limestone does not appear in the Johnstown Section in connection with what we have chosen to regard as the Upper Freeport Coal. It may not have been discovered, as the beds elsewhere range in close proximity through this subdivision of the First Basin, maintaining a position about 40 feet above the Lower Freeport Coal where the latter is present. The coal-bed averages 2 feet on Castleman's River, and nearly 4 feet on the Conemaugh, in the few localities where it has been discovered. The limestone stratum probably never exceeds a thickness of 3 feet.

Above the beds last mentioned, the Mahoning Sandstone spreads with little interruption, forming the top stratum of the Freeport Group, and supporting at Johnstown the great ore-stratum and the Elk Lick Coal. The barren measures compose all the hill country along the middle of the synclinal trough. Proceeding S., these measures thicken and the hills grow higher, but never so as to take into their summits the Pittsburg Coal-seam as in the first or Salisbury subdivision. They exhibit upon their sides in the neighbourhood of the Turkey Foot, or junction of the three branches of the Youghiogheny, the most beautiful series of terraces formed by the successive and horizontal, soft and hard strata of coal, slate, and sandstone, among which are the Elk Lick Coal and the two minor seams above it. If the Pittsburg seam enters our State at all in this subdivision of the First Basin, it must be for only a very small distance N. of the Maryland line. There is a bare possibility of its existence in the N. part of the central line near the Conemaugh, S. of Johnstown, where, throughout a range of several miles, a conspicuous coal-bench is visible at many points upon the very highest land and in a position agreeing with that which this important bed ought to occupy, adopting the Ligonier Section of the next basin as a standard of measurement.

CHAPTER II.

THE SECOND COAL-BASIN; OR LIGONIER VALLEY.

TOPOGRAPHICALLY, this is the best-defined basin in the bituminous coal region—simple and symmetrical—and having on each side of it a long and regular mountain. The synclinal axis of the trough coincides with the central line of the valley.

The reader must not allow himself to be perplexed by a singular transference of the names of the two bounding ridges, after passing to the S. side of the Youghiogheny. In Virginia the Western Ridge is called Laurel Hill, and the Eastern, Chestnut Ridge. We shall always speak of them as they are known in Pennsylvania.

Seldom rising to a greater height above the valley than 900 feet, and resting on a base from 3 to 5 miles wide, these mountains are broad and regular swells, deeply cut on either side by the head-waters of streams which descend at right angles from their axis-lines. The Vespertine sandstone crowns the broad arch along the level back of each, and is overlapped on each flank by the Umbral red shales, and these again by the Seral conglomerate. Sometimes, however, this last formation has more successfully resisted the ancient denudation, and rides over all, arching the axis, and standing up in humps along the summit of the mountain.

The central parts of the basin are occupied by the barren measures, capped in one locality between the Conemaugh and Loyalhanna by the Pittsburg coal-bed and the still superior Waynesburg Coal group. On each side of the Barren Measures, first the Freeport and then the Clarion group of coal and limestone beds, enclosed in massive layers of sandstone, rise upon the inner flank of either mountain, and contrast in a marked manner with the shaly system of the middle range of hills composed of Barren Measures. These lower sandstone strata, outcropping E. and W., present their high, steep, and ragged lines of isolated hills towards the foot of either mountain, or even invade half the height of its gently-sloping side: they rest upon the Seral conglomerate.—(See General Section IX.)

Where the mountains are cleft by such streams as the Youghiogheny, Loyalhanna, and Conemaugh, the top rocks of the Vergent series, which never rise very high above the water-level, appear at the axis or crown of the arch.

The coal-basin maintains a very uniform width of 6 or 7 miles. The dip of the rocks seldom exceeds 7°, except along the E. edge, or rather in the lower slope of Laurel Hill, where, in some places near the Youghiogheny, it amounts even to 30°. In the centre of the basin the rocks are nearly horizontal, and deeply trenched into numerous subordinate valleys.

Along the Conemaugh are exposed the beds of the Clarion group and of the Freeport group above it; and here also the Brookville and Clarion coals are represented by one double bed, varying from 3 to 5½ feet in thickness.

The Ferriferous Coal, next in order ascending, is 22 inches in thickness, underlaid by its limestone 3 feet thick. In one locality 8 inches of this is hydraulic lime.

The Kittanning Coal is not observable. The lower Freeport Coal is from 2 to 3½ feet thick, and is underlaid by limestone; and the Upper Freeport Coal, with 3 feet of impure limestone underneath it, is from 5 to 6 feet thick.

These are all included within 160 feet of strata, so that all the intervals are near their minimum of thickness. But as we proceed Southward they become greatly enlarged, so that at the mouth of Indian Creek, upon the Youghiogheny, the same series of rocks are found to occupy a vertical space of 260 feet. There the Ferriferous Coal has expanded to 4½ feet, and the Lower Freeport Coal has disappeared. The Ferriferous Limestone, also, has increased in thickness to 8 feet; 15 feet above the coal is a workable band of iron ore.—(See Section on Indian Creek, Chapter XXIX.)

In the Barren Measures which everywhere form the central mass of the basin, are two small seams of coal. —(See Column at Ligonier, Chapter XXIX.) The upper one has a small bed of limestone, 1½ feet thick, resting upon it; this is doubtless referable to the position occupied by a limestone of about equal thickness, mentioned in the suite of beds in the first subdivision of the First Basin, as occurring 60 feet beneath the Pittsburg Coal-bed.

Between the Loyalhanna and Conemaugh, and along the exact centre of the basin, runs a high but very narrow hill, dividing, as it were, the valley into two. On each side of this long hill, and horizontally stratified through it, there crops out the great Pittsburg Coal-seam, from 7 to 10 feet thick. It is a mere reduplication of the appearances presented by the similar narrow bed between the Elk Lick Creek and Castleman's River, described in treating of the first subdivision of the First Basin.

Twenty feet beneath the Pittsburg Bed runs the outcrop of a limestone seam from 3 to 9 feet thick; and 25 feet below the latter may be seen the outcrop of a coal-bed 3 feet thick; and 8 feet under this another limestone, 3 feet thick. The appearance of these calcareous strata underneath the Pittsburg Seam is indicative of a

law that the calcareous depositions increase towards the W., both the number and the thickness of the individual beds augmenting in that direction. We shall see the same fact hold good of the Limestone Strata of the Waynesburg Group, above the Pittsburg Seam.

At the summit of the hill above described are the same two superior beds of the Salisbury Section (see Column for Elk Lick Creek, Chapter XXIX.), the Sewickly Coal and Uniontown Coal, each 3 feet thick, but not separated by so wide an interval as in the former instance, and including between them a new limestone bed, 4 feet in thickness. Forty feet above the upper of these coal-beds is seen the highest limestone of the Salisbury Section, here 7 feet thick.

South of the Youghiogheny detailed examinations are yet required, but those made led to the belief that no material change of type in the series of strata presents itself. Here, as in the southern part of the First Basin, along Laurel Hill Creek, and further South, we find the rocks of the Sharon Group beginning to develop themselves: they contain at Stewart's Furnace a coal-bed 4 feet thick. This bed of coal underlies by 20 feet the bed of ore, which there, as elsewhere, marks the plane of separation between the Seral conglomerate and the Umbral Red Shales below it.

In this southern extremity of the Second Basin, the Ferriferous Coal appears 3 feet thick; 30 feet above it, the Kittanning Coal, 3 feet 2 inches thick; and 25 feet higher still, the undeveloped outcrop of the Lower Freeport Coal-bed.

CHAPTER III.

THE THIRD BASIN AND ITS SUBDIVISIONS, BEING THE REGION W. OF CHESTNUT RIDGE, AND S. OF THE CONEMAUGH AND OHIO.

THE region now to be described presents great uniformity of topographical aspect; its denudation is deep and irregular, and its whole surface a continued series of hills in no one defined range. Large streams, such as the Conemaugh, the Loyalhanna, the Sewickly, the Youghiogheny, Jacob's Creek, Redstone Creek, and the Monongahela River, meander through extensive valleys, and the upper waters of their innumerable side-streams are interlocked, and cover the land with a meshwork of hill and valley that bids defiance to precise description. The few marked features that present themselves amid this general uniformity will be noticed in their places.

The strata descending W. from the axis of Chestnut Ridge undulate gently over the crests of three parallel lines of anticlinal elevation, between that axis and the Ohio River at Pittsburg. These lines of elevation do not declare themselves by very positive features in the topography. Indeed, even a geologist might traverse the district, and would scarcely suspect, except at a few places, from surface indications alone, that there were such lines of elevation crossing the country upon which he looked. They are, however, occasionally marked in the general landscape as seen from some favourable points; seldom, indeed, as distinct ridges with regular declensions either way from continuous central lines or axes, but as ranges of hills distinguishable from the multitude of other hills in the synclinal troughs merely by a somewhat superior altitude and a marked sterility of soil. The first two of these lines of elevation are to be considered as sub-axes of the Third Basin; the other, or Westernmost, as the prolongation of its Western boundary, the third axis.

The first sub-axis of the Third Basin crosses the Conemaugh about 5 miles below the axis of Chestnut Ridge, and, running very regularly parallel with the latter, crosses the Monongahela below the mouth of Cheat River. There it shows a very gently-curving arch, having flattened very much from the point where it crosses the Redstone Creek. Its course is not precisely parallel with the axis of Chestnut Ridge as it gradually but very slowly diverges from it Southward, so that upon the National Road the interval between them has increased from 5 to $7\frac{1}{4}$ miles. Thence it maintains this interval to the Virginia line. It forms Brush Ridge.

The second sub-axis of the Third Basin crosses the Conemaugh, or Kiskiminetas River, about 5 miles W. of the first, and about 4 miles above Saltzburg; and runs S. parallel with it until within $1\frac{1}{2}$ miles of the Big Sewickly, where it can no longer be observed to affect the strata. It resembles the first sub-axis in every

particular, sometimes clearly marked by higher hills, sometimes obscure. It seems not to have suffered so much from denuding agencies as the other, excepting at its S. termination, where it is greatly abraded.

It is everywhere to be distinguishable to the least observant eye, by the marked barrenness of the soil under which it passes; which is due to the uplifting along its line of the coarse sandstone strata of the Clarion and Freeport Groups.—(See General Section IX.)

The third axis crosses the Kiskiminetas 4½ miles above Warren, but rapidly declines, and in a few miles disappears; as does also the fourth axis, which crosses the Kiskiminetas below Leechburg. The influence of these two axes may be regarded as active in producing the wide horizontality of the rocks throughout the region around Pittsburg.

First Subdivision of the Third Basin.—To obtain a general view of the Coal-measures overspreading the country to the W., a few words respecting them, as they repose upon the W. slope of Chestnut Ridge, will be sufficient. The Chestnut Ridge is denuded, more or less deeply, along the whole of its course from N. to S., by the small creeks or brooks which carry off the water that falls upon its broad summit; these flow down into the basin at its foot, turning at right angles, and running along its base, either S. or N., towards the nearest larger stream. In the ravines of a few of the runs even the Umbral Red Shales appear; in others, the lowest rock exposed is the Seral conglomerate; but in those midway between the larger streams, and where denudation has acted with least energy, even the lowest Coal-measures are not brought up to the day; but their outcrops must be sought high up the side and near the top of the Ridge.

As little success was here met with in attempting to identify and trace distinctly the various beds of the Clarion and Brookville Groups, with the coals below them, as observed and described in the N.W. outcropping of the Coal-measures, that classification will not be carefully observed in the following description of the geology of this region, but the whole series of rocks will be thrown into three groups, an arrangement which will not interfere with the former.

The Lower Group will include the Freeport and Clarion Groups of our previous classification, up to the Mahoning Sandstone. Its strata are chiefly massive sandstones. Lying as they do just upon the conglomerate, which itself forms the side and often the top of the Ridge, they possess a strongly-marked topographical character of their own, and, where denudation has not been too energetic, form a uniform terrace along the side of the ridge: elsewhere, a range of high, pointed, rugged hills, which at the entrances of gaps, such as the Gap of the Youghiogheny at Connellsville, become most prominent objects in the natural scenery of the country. But as these sandstones are not persistent in character, and are often interstratified with soft rocks, such as shales or slates, the single range of these hills is sometimes repeated, another range lying inside of the first towards the middle of the basin: between the two flow the little streams which have issued from the ravines of the mountain. Upon the terrace, or upon the sides of the ranges of hills, the lower Coal-beds outcrop; but generally the upper part of the interior or W. range of hills is composed of the middle group, sometimes even the large Pittsburg Coal-bed appearing at the summit.

The Middle or Barren Group is composed chiefly of shales, with one or two massive bands of sandstone in the middle and lower part. These latter, riding over the small axis to the W., cause the characteristic barrenness of the country traversed by them, which has been already mentioned. The group contains three Coal-beds, the Elk Lick and two superior beds, to which, in this region, have been assigned the names of the Barren Coal and the Little Pittsburg Coal. Whether the imperfect identification of these with the two superior small coal-seams of the Barren measures, in the first subdivision of the First Basin and in the Second Basin, will justify the application of these names to those also, is left to future observers to determine. Besides these, one or two thin seams occur which are not classified at present. The whole thickness of this group of rocks seems to be surprisingly uniform along the Chestnut Ridge. The interval between the Upper Freeport Coal at the base and the Pittsburg Coal at the top varies only from 600 feet in the N. part of the basin to 700 feet in the S.*

The Upper Group, based upon the great Pittsburg Seam, and including the Waynesburg Series, occupies the centre of the trough, and is characterised by an enormous development of limestone strata in its lower part, and

* In the Morgantown Section, given in the Virginia Geological Report for 1840, the interval is 525 feet.

the frequent occurrence of calcareous rocks throughout, as well as by the number and importance of its coal-beds towards the bottom of the series. Where the basin is deepest, this group measures 500 feet in vertical thickness, and contains 5 identifiable coal-seams—the Pittsburg, the Redstone, the Sewickly, the Uniontown, and the Waynesburg Beds—with several not yet classified.

Lower or Clarion and Freeport Group.—The Seral conglomerate upon which this group is based is apparently but a few feet thick where brought up by the second axis in the Gap of the Conemaugh. At the Gap of the Youghiogheny it exhibits quite a vertical section of 70 feet, and of 60 feet at the Virginia State line. As exposed upon Dunbar Creek, it exhibits a mass of curled and twisted strata 100 feet in thickness.

Beneath it, one small coal-bed—that of the Sharon Group—6 inches thick, makes its appearance on Dunbar Creek, in connection with the valuable iron-ore of the Umbral Red Shales. The same is seen upon the National Turnpike, where it ascends the ridge.

Although abundantly sufficient data have been collected to establish the main points of identity of this group of coal-bearing strata above the Seral conglomerate, as a group, and to prove the persistency of their general features, as found in the more northern parts of the great Bituminous Coal-field, yet great difficulty has been experienced in tracing the individual beds of coal in the district before us. Their dividing sandstones form an almost uninterrupted continuation upward of the Seral conglomerate, the debris of which covers up their outcrops, thin as they generally are, along the ravines, and conceals, in like manner, their best indices, the limestone bands, by which we have traced them throughout the region already described; while the presence of the more available coal-seams of the Waynesburg Group, nowhere more distant than a mile or two, and easily opened on the sides of their hills of shale, has withdrawn inducements which the inhabitants would otherwise have felt to develop these lower coals.

The lowest coal-bed—the Brookville or Clarion Coal—immediately overlies the Seral conglomerate. Towards the N. it is of considerable thickness, but thins as we trace it S. In the Gap of the Conemaugh it is 4 feet thick; in that of the Loyalhanna, 5½ feet; at Morgantown, in Virginia, it averages 2 feet.*

The Ferriferous Coal-bed at the Gap of the Conemaugh is between 5 and 6 feet thick; beneath it is its limestone, 2 feet thick. At a point N. of the Youghiogheny River it was observed again, under a thin calcareous stratum, having a thickness of 2 feet. At this locality a band of nodular iron-ore occurs, 30 feet below the coal, which corresponds with a similar band of iron-ore in the first basin, exhibited in a section taken along Laurel Hill Creek.

The Lower Freeport Coal has been found as difficult to trace throughout this basin as the coal-beds underneath it. Everywhere along the side of Chestnut Ridge two coal-beds may be seen, separated by an interval of sandstone strata from 50 to 100 feet in thickness; the interval apparently increases S. and N. towards the heads of Jacob's Creek: these are the Upper and Lower Freeport Coal-beds. The Freeport Limestone was occasionally seen between them, in the sections made along the State line. The Lower Coal-bed averages 2 feet in thickness, but attains a thickness of 3 feet on Jacob's Creek. On the Loyalhanna, on the E. side of the first sub-axis, it is 2½ feet thick.

The Upper Freeport Coal-bed has an average thickness of 4 feet, and is almost everywhere a double bed. In the vertical section made at Morgantown, Virginia, it seems to be represented by two beds, 12 feet asunder. It is subject, however, to the most remarkable irregularities, varying at one spot, on the Big Sewickly, at the first sub-axis, from a thickness of 18 inches to 5 feet in a short distance; and at another locality, from one bed 3 feet thick, to two beds each 3 feet in thickness. At one place upon the Big Sewickly Creek it measures 9 feet of coal, confused under a wrinkled roof; at other places, it is known to thin away entirely. On Jacob's Creek it varies from slate containing but a few inches of coal, to a bed of coal 4 feet thick, with very little admixture of

* This bed is probably the one struck by a Salt-boring on the Big Sewickly, in the second subdivision of the Third Basin, 3½ feet in thickness, and 150 feet below the Upper Freeport Coal. At the Redstone, also, it appears about 180 feet beneath the Upper Freeport Coal; but it is there only 2½ feet thick. Beyond this, W., it has not been recognised. It is possible that this may be the bed opened on Mount's Creek, above Connellsville, measuring 4 feet thick, the upper 2 feet of which were slaty coal.

slate. The coal is usually good, even when its solidity is impaired. This is the coal-bed that affords, at so many spots along the Sewickly, the Loyalhanna, and at Saltzburg, the fuel for numerous salt-works.

Over this variable bed of coal is seen the Mahoning Sandstone stratum, a coarse-grained, massive rock, with a maximum thickness of 50 feet. It is finely displayed by the side of the first sub-axis, where the latter crosses the Loyalhanna opposite Blairsville, and in many other localities further S. It is generally of a grey colour, curled and twisted, a true contorted sandstone, full of stems and leaves, and exhibiting every mark of rapid deposition. It does not always immediately overlie the coal; for an intervening bed of slate, sometimes 6 or 8 feet thick, is very frequently present; and in one locality, if our identifications are correct, its thickness amounts to 55 feet: this occurs on the Loyalhanna.

The Freeport limestone occasionally shows itself in fragments on the surface, underneath the Upper Freeport Coal-bed. At the Gap of the Loyalhanna a calcareous stratum, 3 feet thick, occurs, 50 feet below, in what is there supposed to be the Upper Freeport Coal, and immediately over a coal-bed. Another calcareous stratum, 2½ feet thick, holds a similarly related position upon Jacob's Creek. The identification of the beds is rendered more doubtful still when the variation of the interval between these Upper and Lower Freeport Coal-beds is observed —an interval often filled by micaceous sandstones. On Jacob's Creek this interval is 43 feet, the Upper Freeport Coal being nearly 4 feet thick, and the Lower, 3 feet. On the Loyalhanna, at the first sub-axis, the interval is but 25 feet between the coal-beds, both measuring 2½ feet. At the Virginia line, the interval is 100 feet, the lower coal being 2 feet thick. At Connellsville, the same two-feet bed is 93 feet below the upper coal. It would therefore seem more than probable that the observations, obtained with great difficulty, have confounded in some sections the Kittanning and Lower Freeport Coal-beds.

This Lower Group is nowhere exposed to the surface S. of the Redstone upon the first sub-axis, nor S. of Loyalhanna upon the line of the second.

Middle or Barren Group.—No phenomenon in the geology of this region is more remarkable than the extraordinary discrepancy between the interval occupied by the Barren Measures in the Third Basin, and that which they fill in the first and second. In the Salisbury division of the First Basin, the vertical distance from the Upper Freeport Coal, through the Barren Measures to the Pittsburg Coal, is only 225 feet; in the Ligonier Valley or second basin (N. end), scarcely 200 feet; not 10 miles to the W. of this locality, where the latter measurements were made, and simply on the other side of the anticlinal axis of Chestnut Ridge, these strata swell to 600 feet in thickness, and that without any apparent increase in the number of economical beds of coal and limestone. The same Elk Lick Creek Barren Coal, and Little Pittsburg Coal, seem to reappear in their proper relative positions, but with a vastly enlarged thickness of interstratified rocks, and these almost wholly composed of immense deposits of argillaceous shales. Error of measurement seems precluded by the repetition of the Ligonier scale beyond Negro Mountain, and of the Saltzburg and Connellsville scale upon the Monogahela, and at Waynesburg, further W. Possibly the great difference in the thickness of the group may arise from there having been an anticlinal barrier already elevated in the sea bottom at the time of the deposition of the materials, causing the rate of this to vary on the two sides.

By a similar comparison of localities, on the two sides of this same axis, far to the N., at Karthaus and at Bennett's Branch, we notice a similar increase of thickness, not in this Middle Barren Group, but in the Lower Group, the rocks between the Upper Freeport and Ferriferous Coals.—(See Sections at Karthaus and Bennett's Branch, Chapters VIII. and IX.)

Midway in the interval of Barren Measures above described, and seemingly persistent throughout the region, is a small coal-bed, averaging 1½ feet thickness. It is of value as an index to the other constituents of the group. Above it rests, in many places, a massive bed of sandstone, supposed to be characteristic of this portion of the series; and in connection with this coal are the "green limestone layers," traced extensively on both sides of the Conemaugh and far to the N. At Saltzburg these are 340 feet below the Pittsburg Coal-seam.

The Elk Lick Coal, 80 feet below the former, in the section made along the Virginia line, is at that place 4 feet thick. It doubtless will be found to occur in a similar position in the series everywhere, the interval increasing perhaps towards the N.; but it must vary greatly in size, as it has been identified at only four localities, by

its usual superior thickness to that of the other coals of the Barren Measures. It issues from the Conemaugh below Livermore, to ascend the second axis; is a 3-feet bed at the head of Jacob's Creek, and 4½ feet thick on the Youghiogheny, in the second subdivision of the basin. It is 4 feet in thickness at Lobizer's Mill on Jacob's Creek, and is there estimated to be 150 feet above the Upper Freeport Coal, for which, despite this great interval, it has more than once been mistaken; but the massive Mahoning Sandstone, which generally overlies the latter, and the abundance of yellow slates and sandstones about the former, will assist in distinguishing them.

The exact position in the series of this middle group to be assigned to a very extensively persistent stratum of red and variegated shales, has not been determined. We are inclined to place them above the sandstone over the Barren Coal-seam. In one locality on Jacob's Creek a fossiliferous limestone is seen at their upper limit, and over this again a stratum of calcareous nodules and ore. These, perhaps, appear upon the Loyalhanna, where the lower limestone is 6 feet thick, impure and weathering yellow; and the upper bed, 60 feet above the other, is 2 feet thick. An exposure of ore and red shale, overlying sandstone strata, somewhere in this part of the series, may be observed on Jacob's Creek, at Hess and Chair's Mill. It is pretty well ascertained that limestone is usually associated with this set of red-shale strata in the Barren Measures: it may be that more than one such occurs at different heights. The Red Shales appear in some sections just over the lower sandstones of the group; in others, not far below the "non-fossiliferous" limestone in its upper part. In the section at Morgantown, Virginia, they occupy a middle position.

The Barren group limestone, as it may be called, is a quite persistent calcareous member of this series, occurring above 150 feet beneath the Pittsburg Coal-seam, and 5, 4, and 3 feet thick respectively, as seen upon George's Creek, the Youghiogheny, and the Conemaugh.

A massive sandstone is observed with some irregularity at a distance below the Pittsburg Coal. It caps many of the hills along the first sub-axis between the Loyalhanna and Sewickly Creeks. It may be observed—70 feet in thickness—in the section made at Pittsburg, about 100 feet below the great seam.

Very small coal-seams are seen in parts of this group; one such is 14 inches thick on Jacob's Creek, and 100 feet above is a 6-inch seam. The same appears in the Morgantown section.

The Little Pittsburg Coal is a bed about 1½ feet thick not everywhere observed, and apparently thinning out towards the W., as it does not make its appearance in the Pittsburg and Waynesburg sections. An average of its variable depth below the Pittsburg Coal would be perhaps 100 feet. Upon the Youghiogheny a limestone lies below it mixed with shale from 4 to 12 feet thick. In the second basin, at Ligonier, this calcareous band is 3 feet thick.

The great limestone stratum at the top of this group properly belongs to the third or upper group, and will be described with the Pittsburg Seam.

THE UPPER OR GREENE COUNTY GROUP.

For a certain space beneath the great Pittsburg Coal-bed, the nominal base of the group, the strata are calcareous, with a tendency to the exhibition of massive limestone beds, even to one 25 feet in thickness, as at Pittsburg. In the Second Basin, near Ligonier, the lowest 5 or 10 feet of this space is a solid limestone stratum, separated by 20 feet of shales from the coal.

At Blairsville on the Conemaugh, at the first sub-axis of the Third Basin, the stratum measures 12 feet. In the Youghiogheny section, and in the Morgantown section, a coal-bed 1½ feet thick is associated with it.

The Pittsburg Coal-Bed, assumed as the base of the upper group, extends along the whole line of the first subdivision, from the Conemaugh to the Virginia State line, and outcrops to the right and left in the first range of hills facing the first sub-axis W., and in the second range of hills facing Chestnut Ridge E. Two miles to the S. of the National Road it arches over the line of the first sub-axis into the second trough or subdivision of the third basin. In the centre of the first trough the Pittsburg Coal-bed descends to within a few feet of the water-level of the Conemaugh, and then sweeps horizontally and ascends again. It appears beneath the water-level on the Loyalhanna for 2 miles, and upon the Youghiogheny for 1¼ miles. On the Sewickly its lowest

point in the centre of its synclinal basin is estimated at 170 feet beneath the water-level. But on Jacob's Creek it does not descend to the stream.

The E. line of outcrop of the coal alternately approaches and recedes from Chestnut Ridge in obedience to an irregularly denuded surface, and in one instance to a small local axis upon Mount's Creek. The distance, therefore, from outcrop to outcrop—that is, the breadth of the area it covers—varies, being 1½ miles at New Derry in the N., but on the Youghiogheny only ¾ of a mile, and if measured straight across along the river, it is 1¼ miles. Approaching the State line it becomes nearly horizontal, and spreads over almost the whole area of country between George's Creek, the Monongahela River, Cheat River, and Chestnut Ridge. Its lowest approach to the water-level there is 173 feet; its highest elevation, 371 feet. In the second subdivision of the Third Basin, W. of the first sub-axis, it sinks again below the water-level in most of the water-courses S. of Jacob's Creek, rising again W. upon the Brownsville continuation of the second sub-axis. Upon the Youghiogheny River it enters the water 1 mile below the mouth of Jacob's Creek, and on the Redstone Creek, 300 yards below Sharpley's Mill, reappearing with an E. dip 1 mile above its mouth. In the third subdivision it comes up from the water-level with an E. dip, near the mouth of Sewickly Creek, and at the mouth of the Youghiogheny River is 25 feet above the stream.

The character of the Pittsburgh Coal-seam in all this region is well marked, showing everywhere a disposition to divide itself into a lower bed of solid coal, and an upper series of thin, alternated, often contorted, seams of coal and slate, in which sometimes the coal predominates, at other times the slate. The lower member is almost universally a good, pure, solid, columnar coal; though towards the Virginia line this also shows a disposition to become more slaty. It is usually free from sulphuret of iron, except along a strip of country lying W.N.W. and E.S.E. in the line of Cat Run, where large lumps of iron pyrites occur.

The thickness of the lower member of the Pittsburg Coal-bed is variable, being 6 feet thick on the Conemaugh, and from 7 to 8½ upon the Loyalhanna. The average thickness of the upper member is 3 or 4 feet; it is far more variable than the other. Sometimes it contains a coal-seam 12 or 15 inches thick, a foot above the lower member, and on this alternations 2 feet thick; and then the lower member is 7½ feet thick: this is in the second trough. At another place an interval of 2 feet of shales separates a coal-bed of 2 feet from the lower member. Again we find 4 feet of alternations, and between these and the lower member 2 feet of sandstone. This rock may indicate the true cause of the wide prevalence of the double character of the bed. Again, at Smythfield may be seen the accompanying Sections, made within 400 yards of each other.

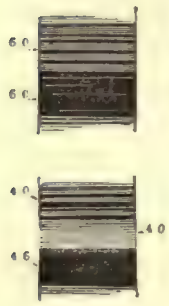


Fig. 332.

Upon the Sewickly Creek the lower member is 9 feet in thickness; the upper one 5½, with a little slate intermixed. This makes the whole bed 14 feet thick, which is its thickness in the Waynesburg section.

We may consider its average thickness in this basin, 10 feet; in the second basin, 8½ feet; in the Salisbury subdivision of the first basin, 9 feet. Still further E., in the isolated basin of Savage Mountain, it may perhaps be recognised as the equivalent of a double bed of coal 7½ and 4 feet thick, overlaid at a distance of 90 feet by a seam 14 feet in thickness.

The ore at Savage Mountain occurs as bands of carbonate of iron nodules imbedded in shale below, between, and above the two members of the double coal-bed. In the Salisbury Basin, iron-ore is found below the Pittsburg Bed; the quality and quantity are unknown. At Oliphant's Furnace the ore is obtained under the coal; and the same ore is said to have been found at Mount Braddock, S.E. of Uniontown, in the same position; but it is nowhere wrought N. of Redstone Creek. It was not seen in the Ligonier Valley or Second Basin. It is certainly a question why it should range only S. of a particular line.

In the second trough or subdivision the Pittsburg Coal-bed extends in the shape of a canoe from a point a few miles to the N. of New Alexandria, on the Loyalhanna, to a point 3 miles S. of Greensburg. Over this area the rocks above this bed have no great vertical height. On the N. side of the Loyalhanna Valley the bed has escaped denudation only upon the W. side of the trough, and is there 8 feet thick, with its characteristic divisions.

The Pittsburg Sandstone.—The characteristic rock above the Pittsburg Coal-bed is a massive sandstone stratum irregularly stratified, weathering with roundish holes, and, where exposed along the Conemaugh and Loyalhanna streams, from 30 to 50 feet in thickness. It is a rock with variable aspect, but the interval between the Pittsburg Coal and the next bed above is a sandstone interval. It appears—25 feet thick—in Greene County and at Pittsburg, and 40 feet in the Salisbury trough of the First Basin. It forms "the Barrens" near New Derry in the N. part of the first trough of the Third Basin. A few feet of shales usually prevent this sandstone from resting immediately upon the upper member of the Pittsburg Coal-bed; and these shales sometimes attain a thickness of 20 feet. In some few instances, as at Wheeling, the sandstone stratum is wholly wanting, its place being supplied by more argillaceous or calcareous rocks.

The Redstone Coal.—In the Salisbury Basin (Column of strata at Elk Lick Creek, Chapter XXIX.) the outcrop of a large coal-bed is marked 40 feet above the outcrop of the Pittsburg Coal. In the Ligonier Valley a 3-feet bed of coal occurs at half that height. In the Third Basin, on Redstone Creek, and at Mount Braddock, to the S.E. of Connellsville, a coal-bed, varying from 2 to 3½ feet, the smut at the outcrop of which is occasionally seen to the N., but not to the S. of the Redstone, has been opened at a height of 45 or 50 feet above the Pittsburg Coal-bed. At Mount Braddock the coal is interlaid with slate. In Virginia the same bed is traceable, from 3 to 4 feet in thickness in the neighbourhood of Morgantown; but at Wheeling it presents an outcrop of only 5 inches.

The Sewickly Coal.—The next coal-seam in the ascending order is to be found at an average height of 100 feet above the Pittsburg Seam, and in two instances it is enclosed between two layers of the Great Limestone. The average thickness it exhibits may be stated at 4½ feet, though it ranges in places from 1½ to 5½ feet. It measures 3 feet in the Ligonier Section of the Second Basin, and 5½ feet in the Virginia Section at Morgantown. At Wheeling it is scarcely visible.

In tracing this Sewickly Coal-bed, and the one below it, the Redstone Coal, beyond the Alleghany Mountain, over into the Savage-Mountain Basin, one can only refer to the two coal-beds there exhibited as 12 feet apart, the upper one measuring 5½ and the lower 14 feet in thickness, and at a proper elevation of 90 feet above the double Pittsburg Vein. The great thickness of the lower bed is the most striking feature in this analysis of identity. As the Redstone Coal thins away Westward to almost nothing at Wheeling, there is a probability of its thickening Eastward even to 14 feet in this outlying basin. It may be observed here that the ore-bearing shale beneath the lower 14-feet bed, has its representative in the section made at Uniontown beneath the Redstone Coal. As to their close approximation in the Savage-Mountain Basin, the same is true of them at Wheeling, where they have reached extreme tenuity, and are but 24 feet asunder. In conclusion, it is proper to say, that the rocks of this upper group, although denuded from over such extensive areas, and having therefore many links deficient in the chain of their exposures across the country, furnish sufficiently ample data to establish results which would have been regarded but a few years back as quite chimerical.

The Sewickly Coal-bed is first seen as we trace it S. from the Conemaugh, W. of the Chestnut Ridge, upon Sewickly Creek. It is here nearly 5 feet thick, with 20 feet of dark-blue and brownish shales above.

Near Uniontown there rests upon it a curled and twisted sandstone, full of wedges and chips of coal; it has usually limestone over it. At Mount Braddock it is 4 feet thick; but on the Youghiogheny only 15 inches. To the S. of George's Creek it is much swept away, although it occurs even S. of Cheat River. To the S.W. of Redstone Creek it has been opened in several localities, and is 4 feet thick.

In the second sub-basin it is not found at Greensburg, but on the Big Sewickly Creek, not far distant, it is observed. It rises from the water of the creek at a point three miles below Markle's Mill, with E. dip. The Pittsburg Coal rises at a point one mile lower down the creek, or two miles above the creek's mouth.

The Great Limestone-Bed.—This is a series of alternate calcareous and argillaceous strata, varying in thickness and composition, the whole mass being of greater or less compass in section, according to the upper limit assigned to it. Upon the Monongahela, in the neighbourhood of Pittsburg, its thickness is estimated at 60 or 70 feet, enclosing the Sewickly Coal-bed, and extending upwards to a seam of coal. The Uniontown Coal is 1 foot thick; a calcareous stratum 8 feet in thickness, which may be thrown into the general mass, occurs 25 feet still higher than this coal, and with that the limestone deposits in the section seem to cease.

At Wheeling the expansion of these strata is enormous; the deposition of calcareous matter, commencing immediately above the Pittsburg Coal, has been continued with slight interruptions, and some admixture of argillaceous ingredients, for a vertical height of about 260 feet, of which 160 feet of technically solid limestone may be seen. Two small beds of coal in the lower part, and a third in its upper limit, subdivide this vast deposit. In the neighbourhood of Waynesburg, in Greene County, these coal-seams do not appear in the section, but the calcareous deposit is exposed in three coherent layers, the lowermost 16 feet thick; then, after an interval, 31 feet of shales, the middle band 18 feet thick; and after another interval of 40 feet, the uppermost (corresponding to the 8-feet limestone in the Pittsburg Section) 8 feet thick.

Upon the Sewickly Creek in the third sub-basin there is one great deposit of limestone 70 feet in thickness, and four smaller ones, measuring in the aggregate 40 feet. Upon the Youghiogheny it is divided by the plane of the Sewickly Coal-bed, 24 feet of limestone underlying the coal, and 22 feet of limestone overlying it; while more than 50 feet of calcareous argillaceous alternations occur above the upper member. At the broad ford of the Youghiogheny, it is exposed in two beds 50 feet asunder: the upper bed is 40 feet, the lower one 35 feet in thickness. It wears a similar aspect in the Virginia section at Morgantown, where it is also divided into two beds 50 and 8 feet in thickness, the Sewickly and Redstone coal-beds occurring in the interval. This appears to be its type where perfectly developed, but it is subject to amazing changes: it thickens and consolidates remarkably when traced towards the Youghiogheny River, not presenting an equal thickness, even at points so near as the exposures upon Jacob's Creek. It is finely exposed upon Mill Creek, south of the Youghiogheny River.

Upon the Redstone Creek the limestone exhibits one great belt 67 feet thick, and many smaller bands above. Traced S. from the Youghiogheny, the strata rising with the Basin, this limestone caps the highest hills. To the S. of George's Creek, perhaps only the lowest member enters the highest summits. It forms a high narrow wall-like ridge between the Youghiogheny and Mount's Creek. Traced E., we see the Great Limestone represented in the Ligonier Section of the Second Basin, by one bed 4 feet thick beneath, and another a 7-feet bed, 30 or 40 feet above the Sewickly Coal. While in the Salisbury trough of the First Basin, we were prevented from learning true accounts of its diminished volume, by finding only its debris covering *in situ* the summit of the central ridge. Shales of various colours are freely intermixed with these limestone strata. In the Third Basin they are said to contain no fossils. Elsewhere some layers are reported to be fossiliferous, while "the thick strata do not contain any fossils."

The Uniontown Coal is a small bed about 200 feet above the Pittsburg Coal; consisting rather of two beds, each 1 foot thick. In the second sub-basin, on the Redstone Creek, it averages 3½ feet. It is not invariably a double bed. It is not yet opened, nor do the rocks above it extend far S. of the National Road; it is perhaps Judge Ewing's 3-feet bed. It is not visible in the Waynesburg Section; and neither the first nor second basins to the Eastward are deep enough to receive it. Henceforth the area of observation, as we ascend in the general series, will continually circumscribe itself, and will finally be confined wholly to Greene County.

The 8-feet stratum of limestone mentioned in the description of the Great Limestone, as occurring at its upper limit, lies between the Uniontown Coal and the coal-bed next above, and adds a new feature to the remarkable continuity over such a wide area of the upper beds of the group of strata as we are considering. In the first sub-basin W. of the Chestnut Ridge it is 8 feet thick; in the second sub-basin, upon the Redstone Creek, it is 10 feet thick; on the Big Sewickly, 8 feet; the same in the Pittsburg Section, and always occupying the same position.

The Waynesburg Coal-Bed.—In the second trough of the Third Basin this measures 5 feet, and lies at an elevation of 300 feet above the Pittsburg Seam. In the Pittsburg and Waynesburg sections it measures 6 feet, and is but 250 feet above the Pittsburg Seam. N. of Mount Pleasant, in Westmoreland County, this bed is the highest in the series, measuring 5 or 6 feet thick; but it has not been found to the S. of that point. Near Uniontown it occurs only 1½ feet thick, and at one locality on the Redstone, 2 feet thick. This seems to be a local degradation of the bed.

There are two exposures of coal-beds which have been ascribed to the Waynesburg Bed, but they do not at all correspond with it in general character. The coal is in thin layers, alternating with thin layers of black slate, the whole measuring 5 feet at Cox's, S. of the Youghiogheny River in the first sub-basin. On the Big Sewickly, at

one locality, the same alternations occur, measuring 9 feet in thickness. Several circumstances are calculated to throw doubt upon the identity of these beds with the Waynesburg Coal. At the first-mentioned locality there is evidence of the presence of a bed of good coal, 4 feet in thickness, and open three-quarters of a mile distant, which is more likely to be the Waynesburg Coal-bed.

Above the Waynesburg Coal-bed occur yellow and olive shales and thin sandstone layers, occasionally interstratified.

The highest notable bed left undenuded in the S.W. parts of the Third Basin, lies 55 feet above the Waynesburg Coal, in the Waynesburg Section, and is 2 feet thick; sandstone strata intervene between the beds. Though nowhere opened in the Eastern subdivisions of the Third Basin, its outcrop smut is seen, with that of two others in the neighbourhood of Uniontown, where the first subdivision holds the greatest height of rocks.

This seam is the highest in the series; it is underlaid by sandstone strata, 49 feet thick, beneath which rests a 4-feet seam of coal. These beds are thought to be recognisable in the Savage Mountain coal-field.

A double limestone-bed overlies the last-mentioned coal, composed of two members, each 4 feet thick, and separated by an interval of 4 feet.

A coal-bed 1 foot thick is seen to outcrop 40 feet above the double bed of limestone, and probably is one of three traceable at intervals of 35 feet around the summits of the Uniontown Hills. The uppermost of the three is perhaps a 10-inch coal-bed, next in order in the Waynesburg Section, 30 feet above the 1-foot bed. 20 feet above this are 3½ feet of limestone.

We have now gained an elevation in the series, at which denudation over the whole country, to the N. and E. of Greene County, effectually precludes all further systematic classification. Rocks higher than those last mentioned are found only in Greene County. A section of the rocks of Greene County was attempted, but proved exceedingly meagre in valuable details. It contains 600 feet of higher strata measured, and 200 still higher unmeasured. In the 600 feet we find three coal-beds, not one of which exceeds 1 foot in thickness, and six small limestone beds at various elevations, the highest being 5 feet thick, and 900 feet above the Pittsburg Coal, by estimation.

The last and highest rock observed is a mass of grey and buff micaceous sandstone, 110 feet thick, occupying the highest ground between the head-waters of Ten-mile and Wheeling creeks. Here, if anywhere in the Great Appalachian Coal-field, the geologist should institute a search for Permean fossils identical with the species lately found in Illinois and Kansas, above the productive Coal-measures.

SUBDIVISION III.

DETAILED DESCRIPTION OF THE BITUMINOUS COAL REGION.

CHAPTER I.

THE FIRST BASIN WESTWARD TO PINE CREEK.

THE Eastern extremity of the first bituminous coal-basin crosses the Loyalsock, near the mouth of Plunkett's Creek. The rocks opposite the mouth of Mill Creek, and along the whole extent of that stream, dip gently to the S.S.E. The conglomerate capping the hills may be traced for miles along their summits. At the very head of Mill Creek, the lower beds of the Vespertine sandstone replace it on the hill-tops; and below the mouth of that stream, on the other side of the Loyalsock, the Ponent red sandstone rises 200 feet in the hill, the remaining height consisting of the flaggy brown Vespertine sandstones. In the latter rock occur thin bands of a poor arenaceous limestone, hardly rich enough in lime to be of any value. It assumes a singularly pitted or worm-eaten surface from atmospheric action. It is sometimes 4 feet thick. Upon the top of the hill above referred to, and at an elevation of about 1000 feet above the stream, occurs the conglomerate, apparently about 40 feet thick, dip-

ping S.S.E. The first anticlinal axis, here very abrupt, exposing the red Ponent sandstones on the stream next W. of Lick Creek (another Mill Creek), is traceable in a W. by S. direction, crossing Pheasant Stream, and then Lycoming Creek, half a mile above the mouth of Pheasant Stream. Eastward it ranges in a perfectly straight line, so as to cross Tunkhannock Creek, just above the mouth of its S. Branch. Nowhere does it exhibit dips so great as along the waters of the Loyalsock. The considerable angle at which the rocks dip N. of the Little Loyalsock, causes nearly the whole thickness of Ponent rocks to crop out in one hill, though the perpendicular depth is about 1000 feet. The olive and greenish slates of the underlying strata at the alternation of the Vergent and Ponent series, also appear: they have been usually supposed to contain copper ore. The Vergent rocks come to the surface, near the confluence of Milk Creek and Lick Creek, while they include a thin bed of fossiliferous limestone of good quality for making lime. Near the limestone rises a brine spring, the water of which furnishes a brackish sediment by evaporation. The bottom lands of the Loyalsock are wider than those on most of the other streams in the Northern counties, and contain many good forms. The neighbouring hills are precipitous and rocky, and remarkable for the distinct features of the benches along their sides. Their height varies from a few hundred to a thousand feet; one of them proved to be 988 feet by measurement. On the N. side of this hill, which is 1 mile above the mouth of Elk Creek, the strata, as far as ascertained, are as follows:—For the first 30 feet above the stream, Ponent red shales, then blue sandstone. Above this occur flaggy argillaceous sandstones, somewhat reddish, but more commonly blue and grey. The flat loose pieces of this rock conceal most of the lower beds, resting on the side of the hill, although it slopes at an angle of nearly 70°. A somewhat reddish and heterogeneous calcareous rock, in large blocks, has fallen a short way down to the water's edge: it is an indifferent limestone, probably unfit for use. At the height of 568 feet occurs a bold bench or perpendicular cliff, formed by a bed of coarse white sandstone and conglomerate, about 80 feet thick, embracing a curious variety of white shale 1 foot in thickness. Receding from this escarpment occurs a shelf or terrace of very gentle slope, from which the hill rises by a steep and regular acclivity to the very summit, which is covered with scattered pieces of coarse conglomerate. This hill and the adjoining rivulets were closely examined, and a few excavations were made, without discovering any trace of either iron ore or coal: the latter ought to have presented itself, had the bench described been formed by the Seral conglomerate. A band of red shale near the summit belongs probably to the Vespertine red shales, and may possibly contain some iron ore. The summit of this hill is a broad flat used as a pasture, and the only artificial enclosure required for the cattle is a single bar put across a narrow passage between two rocks. On the S. of the Loyalsock opposite the last hill, a bench exists, apparently on a level with the top of this, while a knob 40 or 50 feet high rises above it, composed of sandstone and conglomerate. Under this last bed is a thin seam of coal 1 foot thick, overlaid by a foot of slaty cannel coal, and resting on a floor of black bituminous shale. The same band of coal was readily discovered in other places, at the base of similar knobs in the neighbourhood. No iron ore was found. The coarse conglomerate occupies only the very highest knobs. The stratification here described belongs to nearly all the hills lying on this creek.

The country around Elk Creek consists of Vespertine rocks. Hogeland's Branch traverses the Red Shales of that series throughout its whole course; it is a rapid stream descending by a series of waterfalls each from 20 to 40 feet in height.

The scenery at some of these waterfalls is picturesque in a high degree. Near the top of the hills around the head of Hogeland's Branch, we find a stratum of poor bluish limestone 1 foot thick, and among the Red Shales, 200 feet lower down, two others, belonging to the Vespertine and Ponent alternations. A mile or two E. of Hogeland's Branch many loose pieces of the conglomerate are scattered about in large boulders, between the head of that stream and the forks of Loyalsock. The rock is valued by the inhabitants for making millstones. A knowledge of the stratum from whence they are derived would prove a guide in seeking for the Coal-measures. On the highest parts of Bennett's Ridge, at the head of Plunkett's Creek, it lies in place, dipping N.N.W. 4°, and under it we find a bed of the Umbral Red Shale.

It was traced for several miles near the heads of Pleasant Stream and Plunkett's Creek. At 2 or 3 miles below the head of Wallace's Run, though the ridge is very high, it does not occur. Bennett's Ridge runs N.E. through Elkland township, S. of Pleasant Stream. The ridge between Pleasant Creek and Rocky Run contains

only the lower Vespertine rocks: this is about 10 miles above Ralston. Between 5 and 7 miles E. of Ralston the conglomerate is well exposed, capping the hills, and forming an abrupt or sometimes overhanging wall 25 or 30 feet high, full of dark passages and deep holes. It is not practicable to ascertain the existence of any bed of iron ore which may occur beneath this rock without a considerable amount of digging. Approaching Ralston, the conglomerate gradually descends lower into the hills, which, from the deepening of the valley of the stream, have an elevation of at least 1000 feet above its bed.

Where the Berwick and Towanda turnpike crosses the two branches of the Loyalsock, the land being high from the nearness of the heads of the creeks, the upper formations are comparatively low in the hills. Thus, in approaching from the N., an exposure of Vespertine sandstones is perceived at the foot of Sugar Hill, which dips S. 20° E. The hill is estimated to be 350 or 400 feet in height, and is capped by Umbral Red Shales. A level upon the summit, of a mile in breadth, brings us to Shinersville, where the Seral conglomerate makes its appearance in a little bench, but is much better developed on the S. side of Birch Creek, 5 miles E. of Laporte. At the foot of this bench near Shinersville, bog-ore is seen issuing from under it, at the outcrop of the Vespertine Red Shales. The Seral conglomerate is here from 60 to 80 feet thick. Over it, in the hill upon the S. side of Birch Creek, openings were once made in slate, with a covering of coarse grey sandstone 10 or 15 feet thick. No rock overlies this upon the dead level of a mile hence to the descent of the road into the valley of the main Loyalsock.

These openings revealed the presence of a coal-bed, but not its thickness. Within the Seral conglomerate is a thin bed of coal. Upon the main Loyalsock a N.N.W. dip begins to be seen, and from under the Seral conglomerate issue other ferruginous streams, depositing bog-ore along the outcrop of the Vespertine Red Shales, not more than 50 feet above the water in the Creek. Descending the Creek 7 or 8 miles from the turnpike crossing, a bed of conglomerate is found in the bed of the stream.

Ascending the creek an equal distance, openings occur upon the same coal-bed, from which many tons of coal have been conveyed; but its true thickness we have not ascertained.

The hills between the forks of the Loyalsock seem wholly to consist of Vespertine sandstones, though here and there a small patch of conglomerate is visible upon the summit. There is said to be a coal-bed upon the S. side of Sugar Hill, on the main Loyalsock, 2 miles above the forks, the thickness of which, beneath the conglomerate, is from 8 to 10 inches. This corresponds with the 1 foot of coal figured in the Section.

The meagre sections of the coal series, as developed in this shallow outlying basin of the great coal-field, will be as in column. At the bend of the Loyalsock, 5 miles above the mouth of Plunkett's Creek, is Hillsborough, consisting, at the time the survey was made, of one house, and a clearing in a broad valley. Here, on the S. side of the creek, Vespertine sandstones are exposed, dipping S.E., and resting immediately on the Ponent Red strata at the water's edge. 70 or 80 feet of Ponent rocks are exposed above the water, 2½ miles farther down. Between the E. fork of Plunkett's Creek and the Loyalsock, is a hill composed of Vespertine sandstone, loose pieces of Seral conglomerate lying scattered over its surface. The S. dip on the forks of Plunkett's Creek is from 35° to 40°. The North Branch falls in three-fourths of a mile, full 500 feet from the head of "the falls," downward; the rest of its descent to the Loyalsock is quite gentle. Near the falls, a hill, 300 feet high, is composed entirely of Ponent rocks, the strata of the Vespertine series, having but a few fragments upon its surface. A hill at the mouth of Plunkett's Creek was examined, where we were told coal existed. Ponent rocks were found at the bottom, and Vespertine rocks composed most of the hill; no signs of the conglomerate were found upon its top, though it was so high that the whole valley of the Vergent rocks on the N., as far as Burnett's Ridge, was visible from it, and all the hills around were overtopped by it. On a hill between it and the North Branch of Plunkett's Creek, pieces of the conglomerate were observed scattered about.

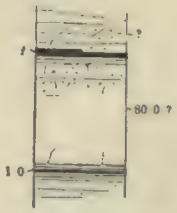


Fig. 333.—Loyalsock.

There are few localities upon the mountains and hills of the Loyalsock where coal is to be found. There is a small bed under the conglomerate, as will be found to obtain elsewhere in the N. basins; there is but one other coal-bed, and that one, over the conglomerate, not great in its thickness, more limited in extent than the conglo-

merate itself, and found principally between the Loyalsock and Birch Creek. Coal is said to be found at the head of the Mahoopeny Creek far to the E. of this.

We are informed that a bed of coal has been found on the Loyalsock Creek, 5 miles S.S.E. of Dushore, in Sullivan County; the bed is 3 feet thick, but contains only 18 inches of coal.

On the Lee or Dutch settlements there is a coal-bed proved on a tributary of the Loyalsock: it is 3 feet 3 inches thick, and contains only 1 inch of slate. The seam is covered by conglomerate of Nut size. It may possibly be identical with the Towanda Bed.

From the same authority we learn that recent explorations for copper have been made at Jonestown, 6 miles S.W. of Laporte; also half a mile W. of the South Branch of the Towanda Creek, on Albany township, Bradford County. In the latter case the ore is said to consist of several varieties, and is interspersed within a band of shale about 3 feet thick. It has been mined to a small extent.

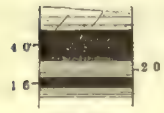


Fig. 334.

Passing to the W. side of the valley of the Lycoming Creek, coal is first opened upon the high summit of the Alleghany, to the left, as we ascend the gorge of Hogeland's Run by the road to the Coganhouse Settlement (see Fig. 334).

Coal, 4 feet; Fire-clay, 2 feet; Coal, 1½ feet; roof sandstone.

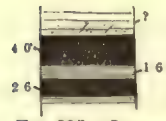


Fig. 335.—Lycoming Creek.

This corresponds very accurately with the measurements of a bed said to have been lately opened at a place 6 miles E. of Hullman's Nail-Factory—which latter is 11 miles above Williamsport, on the Lycoming (see Fig. 335). This is said to read,—

Coal, 4 feet; Fire-clay, 1½ feet; Coal, 2½ feet.

The seam, in both instances, is probably the Tionesta Coal, and corresponds (say the miners) with the sandstone-roof seam of the Tangascootac mines.

Coal was discovered and opened about 18 miles from Williamsport, on the old State Road, between Newbury and Wellsborough. Near the base of the mountain were found loose pieces of slaty sandstone characteristic of the Vespertine series. Above these rocks, which have a perpendicular thickness of about 700 feet, the ridge assumes a more gentle slope, and the soil presents evidence of being derived from the Vespertine Red Shales. This Red Shale is probably not more than 30 or 40 feet in thickness. It is occasionally very ponderous and highly ferruginous, and shows indications of a bed of valuable iron-ore, probably identical with one discovered in other places. Indeed, ore is said to have been found here. Overlying the Red Shale occurs the conglomerate, and loose pieces of other portions of the Seral conglomerate. Its aspect is that of a white silicious sandstone, imbedding small and scattered pebbles of white quartz. It is nowhere visible in place, and is probably about 75 feet thick. Above it occur no rocks in place. The following section exhibits the order of things from the top of the highest bench on the mountain down to the conglomerate:—

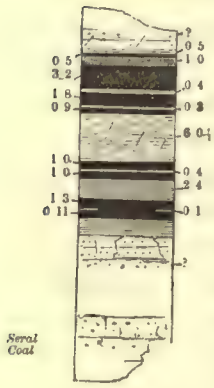


Fig. 336.

Coarse micaceous sandstone containing many vegetable organic remains. Fire-clay, 5 inches; Coal, 5 inches; Clay, 1 foot; Coal, 3 feet 2 inches; Shale, 4 inches; Coal, 20 inches; Clay, 3 inches; Coal, 9 inches. Fire-clay, 6 feet; Fire-clay, with fucoides. Coal, 1 foot; Shale, 4 inches; Coal, 1 foot; Shale, 28 inches; Coal, 15 inches; Shale, 1 inch; Coal, 11 inches. Black Slate, containing *Fucoides*, *Sigillaria*, and *Equisetacea*. Brown sandstone; Seral conglomerate. (See Section, fig. 336.)

This section is compiled from the measurements in several adjacent shafts, in which the quality and thickness are not everywhere strictly the same. The main or upper coal-seam extends for more than a mile along a bench or terrace, which, however, is narrow, the ground sloping rapidly away on both sides down to the conglomerate. Its course is rather irregularly N. for nearly a mile, when it turns E., and gradually falls away towards Hogeland's Run. The S. dip of the Coal-measures soon causes all the coal to disappear as we advance to the N., the Umbral Red Shale coming to the surface and marking the limit of the basin. Beyond these rise the Vespertine sandstones, succeeded by the Ponent Red Shales and sandstones, the latter constituting the principal part of the hill S. of Larry's Creek, and the whole of those lying N. of it, in the tract of country known as the Cogenhouse Settlement. Excavations were made among the Umbral Red Shales N. of the coal, in search of the iron ore which

often occurs in this stratum. The shale in some places is exceedingly heavy, containing much oxide of iron; its colour is similar to that of some ores found in the formation, and might readily deceive an observer into the belief of its being a productive iron-ore. Further explorations, however, will probably result in the development of such in this vicinity.

Eastward of Hogeland's Run, on Bope's Mountain, fair indications of the Coal-measures exist, some pieces of the conglomerate being observed on the highest knobs, in a situation indicating the possibility of coal near the summits.

Towards the W., the mountain falls away to a branch of Larry's Creek, called the Roaring Branch, beyond which it rises again to about the same elevation, presenting a flat area of more than a mile square on its summit. The conglomerate rock seems to lie about 40 feet below the highest part of the hill, the outline of which is such as to imply the existence of the Coal-measures. Further W., the hills continue of nearly the same height, but examinations carried on in that quarter, about the sources of the Western Branch of Larry's Creek, did not result in the discovery of any coal. Coal will, no doubt, be found in insulated patches along the summit of the mountain forming the N. limit of the little valley of Tombs' Run. Certainly the coal-bed underneath the conglomerate must exist there, although of too insignificant a thickness to make a return worth its working.

Explorations to some extent were made, several years ago, for coal on some of these hills, but all the shafts were dug in the strata below the Coal-measures, and the highest ground lying in the centre of the trough was entirely neglected.

The Geological Map will show the range of the basin from Hogeland's Run, across the sources of the different tributaries of Larry's Creek, and thence across Pine Creek, near the mouth of the First Fork; and a reference to General Section No. VII. will show the general position of the coal if present, as well as the anticlinal structure of the little valley of Tombs' Run, with its wide and gentle axis, and the synclinal remnant of the Alleghany escarpment, left upon its S. side, and called Short Mountain. This being composed wholly of Ponent and Vespertine sandstones, is of course not elevated enough to have the coal, or even the Seral conglomerate, upon its summit.

In the high tongue of land between the First Fork and Big Pine Creek, the hills have considerable elevation. Near the level of the stream the Ponent sandstones just make their appearance, being immediately succeeded by the Vespertine, which occupy between 800 and 900 feet of the hills. Above this the slopes become more gentle, the soil indicating the presence of the Red Shale. Here a bench in the side of the hill occurs, containing a white sandstone, referable to the Seral conglomerate. The rock is without pebbles, being a remarkably white and pure sandstone, readily disintegrating, and furnishing a sand that would be well adapted for the manufacture of glass. To this succeeds another band of Red Shale, and in a high knoll we find another white sandstone similar to that just mentioned, above which are beds of olive-coloured slates and argillaceous sandstones, holding nearly the position of the lower seam of coal, the existence of which, however, is not indicated. The lands occupying the head of the North Branch of Ramsay's Run, being near the centre of this basin, are the most certain to reward research for coal. Excavations have been made a little above the mouth of the First Fork, in layers of coaly matter, by persons not familiar with the stratification of the region in a position below the rocks. The quantity of dark slate, similar to that of the Coal-measures, is considerable, and it is said that a coal-seam, 8 inches thick, was found. The exploration was, however, abandoned; and this will always be the case when the search for coal is undertaken so far down the series.

CHAPTER II.

SECOND BITUMINOUS COAL-BASIN, WESTWARD TO PINE CREEK.

THE second great axis, passing E. from Pine Creek, at the mouth of Slate Creek, keeps a distance of 4 miles N. of Ralston and the head of Lycoming Creek, bending with the latter, E. 20° N.

It crosses the Towanda Creek first 3½ miles S. of Canton Corners, then a second time, by bending a little to the N., 4 miles E. of Canton Corners. It then keeps in the hills, running from 1 to 4 miles from the Creek, crosses the head of the bend in the Susquehanna, where Wysox Creek and the Middle Branch of Wyalusing Creek enter it, 3 miles above its union with the East Branch.

The mountain plateau of the second basin is split nearly from one end to the other by the Schroeder Branch, or Middle Branch of Towanda Creek, usually called by the people of Towanda, Canton Creek, which, having its sources on this broad plateau near those of Stony Run, a tributary of the Lycoming, runs away N. 30° E., dividing the mountain mass into two ridges: the one on the S. is called Burnett's Ridge, the other is enclosed between it and the Towanda Creek.

Standing on the Berwick Turnpike, where it crosses the high ridge between the two Loyalsocks, and looking N., we see the line of Burnett's Ridge, broken only by a few little ravines, where the head-runs of the Loyalsock Creek come down, ranging W. from a point on the turnpike, 7 miles S. of Monroe Corners, passing the head-waters of Elk Creek, Hogeland Tract, and joining the main mountain-land between Plunkett's Creek, which descends from it on the S. and Pleasant Stream, which originates on this ridge and flows thence towards Ralston.

The N. division of this mountain-range begins at the Lycoming, above Ralston. Its N. base runs along the S. side of the Lycoming Creek to its head, then in a straight line to the Towanda Creek, a few miles below Canton Corners, and bending gradually round, to suit the course of the Creek, ends at the mouth of the Schroeder's Branch. This will best be seen by reference to the Map. E. of the South Branch, it continues into Frenchtown Bend, and as far down as opposite Wyalusing Creek. But all the E. portion of this is nothing but low hills of Cadent and Vergent, capped by Ponent and Vespertine strata. Thus we see that the mountain-range of the first basin runs on to the Susquehanna; while the similar ridge in the second basin hardly reaches the river, although this is here flowing much towards the W.

Another circumstance should be noticed. In both these instances the axis on the N. of each ridge seems to lie just at its foot, while that on the S. lies far off—effects occasioned by the unequal slope of the two sides of each axis.

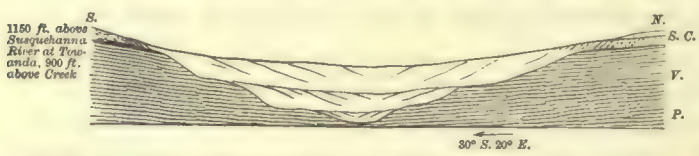


FIG. 337.—Section of Mountains, on sides of Schroeder's Branch, or Carbon Creek, Second Basin.

Coal.—The E. termination of the coal is upon the mountain between the South Branch and Carbon Creek; the W. does not probably pass W. of the township line of Franklin. Loose blocks of conglomerate are occasionally met with W. of that line, on the top of the mountain.

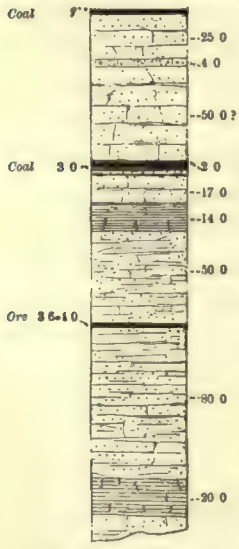


FIG. 338.—Fall Creek. 1 *inch* = 100 *feet*.

The following is a section of the measures at Fall Creek:—

Coal, 0; Sandstone, 25 feet; Pea-conglomerate, 4 feet; Grey and Yellowish Sandstone (some layers coarse and somewhat pebbly, some with coal and charcoal), 50 feet; Slate, with fern impressions, 2 feet; *Coal*, 3 feet; Shale, with Sigillaria, 1 foot; White sandstone, with coaly matter, and impressions, 3 feet; Black slate and coal, 6 inches; White sandstone, somewhat pebbly, with coaly matter, 14 feet; Ferruginous bluish and red shale (position of upper ore-bed), 14 feet; Yellowish-grey fine-grained argillaceous sandstone, 50 feet; Ferruginous shale, and massive mottled grey concretionary iron-ore, 3 feet 6 inches to 4 feet; Yellowish-grey fine-grained argillaceous sandstone, 80 feet; Red shale, 18 to 20 feet; Sandstone, 0.

The upper or main bed has been opened and worked at Mason's Old Mine, 4 miles above the mouth of Carbon Creek, and on the mountain between it and the Towanda Creek, where it was found to measure in coal over 4 feet 7 inches; and also in several places at the old mines 5 miles further W., where it included, according to Mr Johnson's report, from 5 to 7 feet of coal. The following section embraces the strata in the descending order displayed on the stream at Gatiss's Coal Mine:—

Coal, 6 feet; Fire-clay and Sandstone, 20 to 25 feet; White Pea-conglomerate (Seral), 12 feet; Yellowish Sandstone and soft Shale, 50 to 60 feet; Shale and Sandy Marl, 16 feet; Umbral Sandstone ?

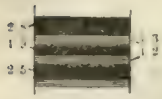


FIG. 339.—Towanda Creek.

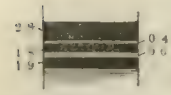


FIG. 340.—Miller's.

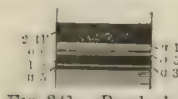


FIG. 341.—Barclay's Drift.

FIG. 342.—Mason's Drift.

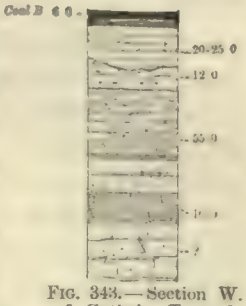


FIG. 343.—Section W. of Gatiss's, Towanda Basin.—1 *inch*=100 *feet*.

Between 2½ and 3 miles W. of the residence of Mr Gatiss, the latter has opened a coal-bed and a deposit of iron ore. The coal is 5 feet 9 inches thick, nearly without slate-partings, and has a sandstone roof and floor of fire-clay. The fire-clay is quite pure, and exceeds 8 feet in thickness. The conglomerate is only 12 or 15 feet below the band of fire-clay. It is about 12 feet thick, and is underlaid by yellowish sandstone and soft shale. Iron ore was found over the upper Red Shale and under the Umbral Sandstone. It was not fully opened, though as much as 12 feet of shale were cut and found full of balls of rough irregular concretionary ore. It is thought (by Mr G.) to be a real stratum.

The following are the subdivisions of the coal at Gatiss's :—

Coal, not mined, very bituminous, 8 to 10 inches; Parting, 0; Coal, 2 feet 4 inches; Slate, 9 inches; Coal (Blacksmith band), 6 inches; Slate, 4 to 5 inches; Coal (suitable for grate), 1 foot 8 inches; Slate, 6 inches; Coal, 6 inches; Fire-clay, 0. Two or three species of Sigillaria are found in this coal.

A lower bed, which, as the section shows, has been opened at Fall Creek, measures about 3 feet of coal. This bed is the only one to be found on the mountain between Carbon Creek, Middle Branch, and South Branch. The top of the mountain is capped by the conglomerate, which forms upon it, as well as on all the other high parts of the ridge, a bold white ledge, visible from a distance.

The conglomerate here is quite coarse, often containing pebbles as large as filberts.

The iron ore under the upper bed lies in three bands, the upper of which yields the best ore. This is a close-grained carbonate, very similar to the ore of the Coal-measures in the Western counties.

At the upper limit of the Vespertine sandstone series, we find on Carbon Creek and in other localities a comparatively worthless stratum of red iron-ore. This ore was opened by Mr Johnson on Fall Creek, at a level of about 70 feet lower than the more valuable Umbral ore which underlies the conglomerate. Here it consisted merely of silicious and argillaceous materials, cemented together by oxide of iron, with some ore-balls intermixed. At other places it appears as a very ferruginous red sandstone.

The Falls of Carbon Creek occupy apparently the very top of the Ponent series, although alternate bands of Red sandstone appear still higher up on the mountain-side. Red shales, of a thickness exceeding 10 feet are seen at the falls, covered by hard white and grey sandstone. The same strata doubtless form the falls of the South Branch of Towanda, where we also meet with a stratum of conglomeritic calcareous Red sandstone, 4 feet thick.

About 50 feet below the coarse Vespertine ore the stream dashes over a rocky ledge 30 feet high, and after flowing a short distance, it makes a second leap of 60 feet. Two hundred yards below this the stream passes over a ledge, composed for the upper 60 feet of grey sandstones of the Vespertine period, and for the lower 20 feet of red and green Ponent shales. Here the stream when swollen by rains forms an imposing and beautiful cascade. From the level of the lower ore the creek falls constantly and rapidly for three-quarters of a mile, when it joins Carbon Creek at a point 206 feet above the mouth of the Towanda. The thickness of the Vespertine series at this locality may be estimated at about 600 feet.

Ralston.—The Ralston Coal-field is only an extension of that of Towanda Westward along the Second Basin. Ralston is situated at the mouth of Stony or Rocky Run on Lycoming Creek, 26 miles above Williamsport on the line of the Williamsport and Elmira Railroad. The hills, which are about 1000 feet high, contain at their base the red rocks lying at the bottom of the Vespertine sandstone series, and surmounted by the conglomerate limestone.

The centre of the coal-basin crosses Lycoming Creek, near the mouth of Dutchman's Run, one mile above Stony Run. The anticlinal axis, forming the S. margin of this basin, crosses near the mouth of Pleasant

Stream, while the other axis, bounding it on the N., passes near the mouth of Roaring Creek. The hills, including the Coal-measures, occupy a range of country E. and W. nearly 10 miles in length; but the coal is not continuous over all this extent, being interrupted by deep valleys of denudation. The principal localities of the coal are on a branch of Stony Run, between that stream and Dutchman's Run, on Red Run, the other side of Lycoming Creek, and on Frozen Run, near Astonville. From Ralston, a waggon-road, at a grade of one foot of elevation to every 17, ascends 3 miles to the mines. The height of the coal above the creek at Ralston is about 875 feet, while Ralston itself lies 808 feet above the tide.

The mines of McIntyre and Robinson are situated on Stony Run, 3 miles from Ralston. The coal-bed worked by them varies from 2½ to 3 feet 2 inches in thickness; the coal is highly columnar, and yields a White-Ash. Iron ore is found in the same position as at Ralston.

On the road leading to the mines, and below the conglomerate, in a bed of dark shale, there is a valuable band of *iron ore*, lying only 4 feet beneath the rock, from which it is separated by a layer of brown shale. It occurs in irregular knotty lumps, closely bedded in a soft reddish and white shale. It forms about one-half of the stratum, and consists of nearly a white crystalline protocarbonate of iron, somewhat resembling a fine-grained sandstone. This is apt to be encrusted with the brown or red oxide. These balls are very solid and heavy, becoming more massive as we penetrate deeper in from the outcrop. In the other half of the bed, which is principally shale, occur scattered balls of the same ore, of a blotched red and white appearance. This ore is admirably suited for the manufacture of foundry iron. This is the valuable Umbral red-shale ore.

The Seral conglomerate in this region varies from 45 to 100 or more feet in thickness: the top of the rock is marked by a terrace, gently receding from the front of the hill to an abrupt slope, formed by a bed of white pebbly sandstone. Between these two sandstone beds we find a seam of rather slaty coal, from 18 to 30 inches thick, underlaid by 30 inches of slate. Over the sandstone occurs another bed of coal, several feet thick, but not of superior quality, the lower part of it consisting of slaty cannel coal, and the rest being rather hard. It includes two bands of slate: one 8 inches, the other, near the bottom, 3 inches thick.

Another coal-seam, between 1 and 2 feet thick, occurs from 5 to 7 feet above the former. It contains 3 inches of slate near the middle, but supplies an excellent coal for cooking, and is much superior to the seam beneath it.

Above this coal we find a bed of shale, containing large nodular balls of *iron ore*, and a little higher another seam of coal one foot in thickness.

A complete section of the strata in the descending order at the *Ralston* Old Mines, on the 3000-acre tract, is appended:—

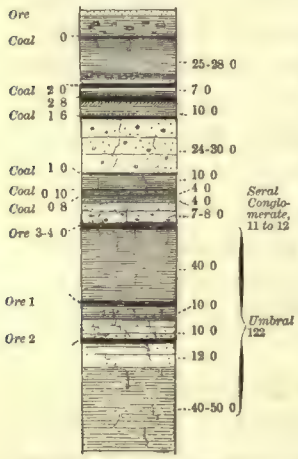


FIG. 344.—Ralston Old Mines. 1 *inch* = 100 *feet*.

Thin bedded shelly sandstone, 4 feet; Shale, with ball-ore, 10 feet; *Coal*, 1 foot; Black slate and shale, 20 feet; *Balls of ore*, 5 inches; Slate, 3 feet; Sandstone, 1 foot 6 inches to 4 feet; *Coal*, 2 feet; Fire-clay, good, 3 feet; Strong slate, 4 feet; *Coal*, 2 feet 8 inches; Fire-clay and sandy shale, 10 feet; *Coal*, 1 foot 6 inches; Conglomeritic sandstone, millstone grit, 24 to 30 feet; *Coal*, 1 foot to 1 foot 3 inches; Clay-slate and shale, 10 feet; *Coal*, 10 inches; Shale, 4 feet; *Coal*, 8 inches; Clay-slate, 3 to 4 feet; Strong brown sandstone, 4 feet; SERAL CONGLOMERATE, 7 to 8 feet; Slaty clay, 6 to 8 inches.

UMBRAL.—*Ore*, some places 3 to 4 feet, here 2 feet; Bluish and greenish clay-shale, 40 feet; *Thin course of balls of good ore in ground*, 1 foot; Clay-shale and black slate, 10 feet; Sandstone, 3 feet; Hard micaceous shelly sandstone, 7 feet; *Red ore-balls*, cold-short, in ground, 2 feet; Green sandstone, 10 to 14 feet; Red shale or marl, 40 to 50 feet.

Crowning the highest part of the hills occurs a bed of conglomerate, 60 feet in thickness, less coarse than the main Seral conglomerate.

The dip of the strata at the mines on Stony Run is gently Westward; on Dutchman's Run on the opposite side it is towards the E.S.E., while a few miles farther up the main branch of Stony Run it is toward the N.W. about 4°.

A somewhat curious feature of this hill are the swamps occurring on its very summit; the largest occupying several acres, entirely destitute of timber, and containing a deposit of *peat* at least 15 feet in depth.

On Red Run the strata are nearly the same as at Ralston. Beneath the conglomerate, the shale containing the iron ore is 34 feet thick, and underneath that is a sandstone 100 feet, succeeded by another bed of red shale. These two red shales correspond with those at Farrandsville, to be hereafter described, excepting that the iron ore occurs at the latter place in the lower bed.

On Dutchman's Run a remarkable slide in the face of the hill has laid bare the Ponent, Vespertine, and Seral conglomerate series.

The following strata are displayed on the Railroad between Astonville and the mines, near Ralston :—

		Feet.	In.
Coal-Measures	Coarse sandstone,	30	0
	Coal, 1 ft. 4 in.—	2	0
	Fire-clay,	5	0
	Coal—4 inches of bony in middle,	2—2	6
	Fire-clay and slate,	5	0
	Coarse and pebbly sandstone,	25	0
	Coaly and bituminous slate,	2	0
	Pea-conglomerate and sandstone,	45	0
Umbral	Blue and red shale,	2—3	0
	Iron-ore,	1—2	0
	Ball-ore in bluish shale,	2	0
	Blue shale, &c.,	30	0
	Blank,	100 ?	
	White conglomerate,	20	0
	Grey and greenish coarse sandstone, often thickly bedded, and obliquely laminated,	350	0
	Red and greenish shales and ferruginous sandstone, with Lepidodendron,	85—90	0
Vespertine	Greenish flaggy sandstone, with beds of grey sandstone and blue slate, obliquely laminated, with 1-foot bed of rotten calcareous brachia, 350 feet visible—in all	475	0
Ponent	Red sandstone and shale,	25	0
	Green sandstone, with brachia,	20	0
	Red shale and sandstone,	150	0
	Level of valley of furnace,	...	

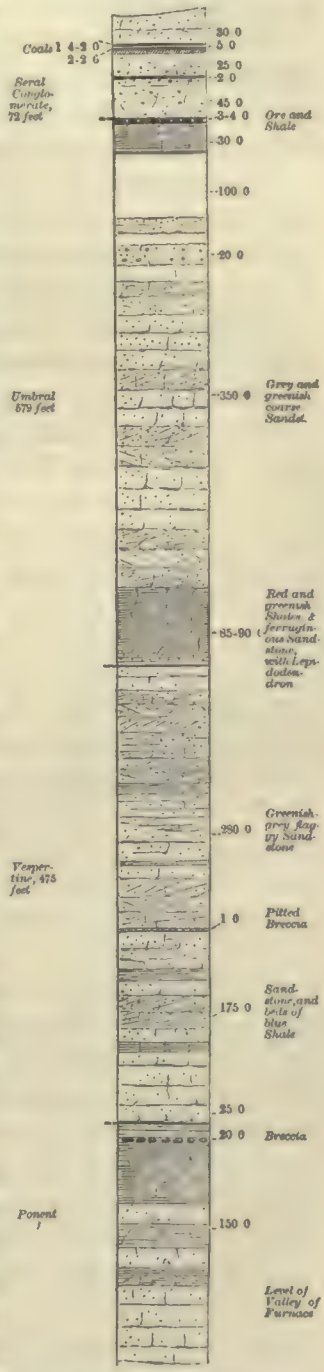


Fig. 345.—Astonville, on Railroad, Ralston District.—1 *inch* = 200 *feet.*

The coal of the Astonville Mines is opened in several drifts. It is in two benches—the lower about 2 or 2½ feet; the upper, from 16 inches to 2 feet. The fire-clay between is 5 feet thick. In the lower coal about midway is a bony layer of 4 inches. Two drifts have been opened at an interval of about 300 yards. The coal is shot down steep slopes or inclined planes.

The ore is drifted on just under the conglomerate, which is pebbly in its lower layers, but a coarse, heavy-bedded Pea-conglomerate, for nearly 50 feet above this. The matrix of the ore is a fine bluish and red mottled argillaceous shale. The ore lies from 4 to 6 feet below the rock. It is a brown and grey carbonate in a bed, not concretionary, from 1 to 2 feet thick, but is now faulty and thin. Below the stratified ore, and nearly in contact with it, is a nodular ore of a concretionary form, and more ponderous. It also is a grey and brown carbonate. These nodules are irregularly placed at intervals in the shale. Below the level of the Ore-drift the rocks are concealed for about 30 feet; but, from the aspect of the surface, I make no doubt this interval is occupied by shales. At 30 feet, a drift,

mined for ore unsuccessfully, has brought to light bluish-grey argillaceous shales, with some impressions of *Lepidodendron*. These shales are evidently somewhat calcareous.

Just S. of the locality of the mines there is a deep ravine, in which a brook descends, and which, on account of the amount of the fallen conglomerate, shows no exposures except just below the Bridge, where there is a mass of flaggy Umbral-like sandstone, included in the section. On the opposite or S. side of the ravine on the Railroad, the first rocks to be seen are immense blocks of a very white Pea-conglomerate, which has the appearance of dipping N., but may be the Seral which has slipped down.

A short distance S. of this, the rock is undoubtedly in place, and is here a coarse, thick-bedded, light-grey sandstone. The mass of this is not less than from 75 to 100 feet, and is succeeded, further S., by a more greenish and flaggy rock, but still generally coarse. Lithologically, these rocks present more clearly the characteristics of the Vespertine Strata than any other, and as such we have chosen to regard them.

Directly behind the Ralston House at the foot of the hill, a crumbly red-shale is seen underlying the heavy cliff of flaggy grey and greenish sandstone. Just at the top of this is a peculiar bluish-grey breccia, apparently calcareous, associated with an impure iron-ore. This rock weathers very ragged and pitted, and is doubtless the same as that marked in the section as in the shales at the top of the Ponent.

As the rocks of the Ralston Hill dip N., while those on the Railroad, for some miles N. of Ralston, dip S., Ralston must be on the S. side of the synclinal, which includes the coal in the higher levels.

Frozen Run enters Lycoming Creek on the W. side below Stony Run.

There are two furnaces at Astonville, a small one using charcoal, which has been in operation successfully, and a complete furnace, 14 feet across the boshes, adapted to hot-blast. This was chilled in the first blast, and is not now (1854) in operation. It was to use anthracite mixed with the coal of the hill. The ore, when roasted, looks grey and vitreous. Three tons of ore are required to yield one ton of metal at the charcoal furnace.

The strata in the hill at *Cartersville*, on the Lycoming Creek, 1½ miles above Ralston, are as follows:—

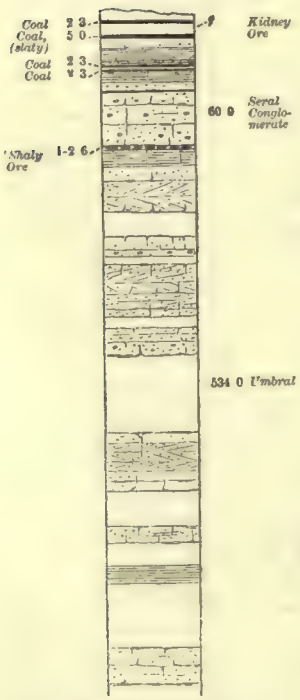


FIG. 346.—Section of Hill at Cartersville, 1½ miles above Ralston.—1 *inch* = 200 *feet*.

		Feet.	In.
	Coal,	2	3
	Blank, said to contain kidney ore,	...	
	Coal—slaty, and not mined,	5	0
	Slate and sandstone,	25—30	0
	Coal—in one bench good,	2—3	0
	Slate,	8—13	0
	Coal—good, and harder than the above,	2—3	0
	Slates, passing into slaty sandstone,	20	0
SERAL.	Sandstone, becoming pebbly,	15	0
	Pea-conglomerate, thick-bedded,	45	0
UMBRAL.	Bluish and red shale,	1—2	0
	Shaly ore,	1—2	0
	Red and blue mottled shales, about	20	0
	Coarse greenish-grey, somewhat pebbly micaceous sandstone, obliquely bedded, and containing vegetable impressions,	50	0
	Blank,	25	0
	Coarse white sandstone, lower beds pebbly,	25	0
	Blank,	10	0
	Coarse sandstone—thin-bedded impressions,	65	0
	Bluish flaggy sandstone,	15	0
	Conglomeritic sandstone,	15	0
	Blank,	85	0
	Bluish and olive micaceous flaggy sandstone (seen at quarry)—some beds argillaceous, abounding in vegetable impressions,	60	0
	Blank, containing a few beds of micaceous sandstone,	80	0
	This brings us to the base of the cliff; below this red shale, and a mass of shaly gravel intervenes to base of Umbral—about	90	0

There can be little doubt that the two lower seams at Cartersville are identical with those worked together in the drifts of the Ralston Hill—the interval in the latter place having diminished. On the highest part of the Ralston Hill, the upper or five-feet seam of Cartersville is said to have been found. At Cartersville there is a seven-inch coal over the highest noted in our section. At the latter locality, ore like that at Ralston is found, about 80 feet beneath the lowest coal. It lies in red and purple olive mottled shales, and in general is more argillaceous than at the Astonville opening, though some masses are solid, containing white and brownish carbonate of iron. Its thickness varies from 1 foot to 2 feet 6 inches. There are two openings upon the bed, entering W. by N. The more S. of these has been driven but a few yards. The ore proved more shaly and impure than that of the other opening; the nodules are often crumbly shale, bluish and mottled purple, charged throughout with carbonate of iron. The average thickness of the bed in the two drifts is about 18 inches.

The furnace at Cartersville is a very solid structure of the Umbral Sandstone of the quarry; it measures 12 feet in the boshes.

The Vespertine Rocks between Ralston and Cartersville dip very gently W. by N.

On the railroad between Ralston and Canton there are, by estimation, from 550 to 600 feet of Ponent sandstones and shales visible; passing these, olive and reddish shales and flags may be seen to the thickness of 120 feet, full of Fucoids, then 50 feet of heavy-bedded greenish sandstone, followed by reddish sandstone 50 feet thick, after which the road passes through 75 feet of red shales and greenish sandstones, and then olive and red sandy slate.

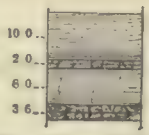


FIG. 347.—Sellard's Ore, on Schroeder's Branch of Towanda Creek, 2 miles S. of Canton.—1 *inch*=40 *feet*.

Near Alba, olive shales of the Vergent are seen dipping N. Between Alba and Troy, and at the latter place, are North-dipping red shales and sandstones of the Ponent and Vespertine series.

Returning S., and crossing Laurel Hill by the road up Trout Run, a N. dip is observed on the S. side of the stream, and a S. dip on the N. side, indicating this as the position of the synclinal axis of the Coal-basin. Ascending the hill, we have indications of the presence of Ponent rocks, for an elevation of from 300 to 400 feet. This is succeeded by Vespertine strata, on the upper side of which we find two bands of the Umbral red shale. *Iron ore*, in loose pieces, was found near the upper of these beds of red shale, and not far from the summit of the hill, which is surmounted by coarse white sandstone and Seral conglomerate. Above this last rock, one of the lower beds of coal may possibly exist, where the knobs rise to a sufficient height from this level. There can be little doubt that the red shale below the conglomerate includes a band of iron ore similar to that found at Ralston.

The country S. of Laurel Hill is extremely rough, being covered by the Umbral and Seral series; but that N. of the hill is more gently undulating, Ponent strata alone capping the hills, and producing a soil fit for farming. The N. anticlinal axis of the Ralston Basin crosses the road a little S. of the county line, while the S. axis passes near the head of Trout Run.

The next place in our progress W., where this basin contains coal, is on the First Fork of Pine Creek. Heavy masses of conglomerate strew the flats along the First Fork, about 3 miles from the mouth of Bear Run, which heads near Larry's Creek. We no longer find the Ponent Rocks above the streams, but they rise to their level near the Block-House Fork, and a little below the old English mills. The hills are between 700 and 800 feet high, containing about 100 feet of the conglomerate, supporting 100 feet more of higher strata. On a stream known as Three-mile or Porcupine Run, opposite Wolf Run, the conglomerate, and above it the brown sandstone, are well exposed. Between them no bed of coal was discovered; but above the sandstone a coal-seam was found consisting of two bands, each about 1 foot thick, separated by a layer of hard shale. The lower band in this seam is a beautiful black shining coal. Below it lies a bed of hard blue shale. Much search was made for iron ore, but without success. Whether other beds of coal exist in this neighbourhood is uncertain, but the country seems well deserving of further investigation. The conglomerate caps the hills on both sides of the fork, a little distance N. and S. from the spot where the coal was found. On the E. side of the fork, and on the Block-House Branch, the indications of coal are less promising than on the W. side. An unsuccessful search was made for the iron ore of the Umbral Red Shale. A ferruginous band in the red shale, about 150 feet beneath

the conglomerate, implies that ore might be found here if an adequately minute exploration were made, assisted by proper diggings. Specimens, seemingly of good quality, were found sticking in the upturned roots of trees between Porcupine Run and the old English mills.

About the time these discoveries on the First Fork of Pine Creek were made, a person seeking for limestone on a wild tract a few miles to the W., stumbled upon a bed of coal; a continuation, perhaps, of the seam above described. In tracing the basin in that direction, other beds were discovered and opened, to which I shall now refer. The localities are at the sources of Otter, Day's, and English's Runs, which empty into the First Fork, and of Trout Run, which empties into Big Pine Creek, below the Second Fork. The surface is gently rolling, but very elevated; the obscurity of the exposures, and a considerable amount of dip in the strata, cause the tracing of the coal in this neighbourhood to be rather difficult, as a section made across the basin here would show.

On the very highest lands to the N. and N.W., the seral conglomerate either caps the summits or leaves very little room for the "brown rock" which overlies it. A dip to the S. carries down these rocks, and soon brings in the coal at a level considerably below the tops of the hills; but the ground continuing to slope also to the S. and E., it becomes difficult to determine how far the coal extends in those directions. About 3 miles N. on the road towards Babb's, the hill suddenly falls off about 200 feet, exposing the lower band of the Umbral, and the upper part of the Vespertine Rocks, brought to this elevation by the S. dip. Still farther North, the level of the country is much lower. Where the road crosses Otter Run, the "brown rock" above the conglomerate just rises to the surface, forming the lower part of the bank; above this is the lowest coal-seam, which is 2 feet 6 inches thick, containing a thin band of fire-clay, and underlaid by another bed of fire-clay 2 feet thick. The outcrop of another coal-seam shows itself a little higher up in the same digging. The fire-clay mentioned is of good quality, suitable for the manufacture of fire-bricks. Another coal-bed was found, 25 feet above the last, in a neighbouring bench in the hill. It was opened too near the surface for us to ascertain its quality; its thickness is 3 feet 8 inches, including 2 inches of slate. Below it lies a bed of fire-clay, similar to that of the Middle Coal-seam. The extent of this upper bed cannot be great, but the other beds probably underlie 50 or more acres of surface.

Tracing the conglomerate towards the N., it appears near the top as a coarse pebbly rock, and lower down as a reddish brown sandstone. The thickness of the whole stratum is about 150 feet. On the N. slope of the hill towards the old English settlement, the Umbral shales appear. About 200 feet lower down the soil indicates the lower red-shale bed, and here possibly the iron ore may exist. The hills N.W. of the coal-openings rise more suddenly, and contain the conglomerate. How much farther the Coal-measures extend towards the S. and E. can only be ascertained by systematic diggings and accurate measurement beyond the resources of the survey. At some places in those directions the elevation seems to be as great as at the coal, but a change of dip must occur before we proceed far in that course. The brown sandstone is exposed below the coal on Otter Run.

Coal may hereafter be found at other points on these high lands between the First Fork and Big Pine Creek, but it cannot occupy much extent of surface. It may be worth the attention of the owners of lands lying at the head of the S.W. Branch of Otter Run, or about 5 miles from Callahan's, to excavate for coal, as the appearances there are indicative of the Coal-measures, and the conglomerate does not reach to the highest summits of the country. Examinations were made there, both for the coal and the iron ore of the Umbral series. A pit dug in the red shale about 12 feet, did not, however, bring either substance to light; but it is probable that, if the ore exists at all in this neighbourhood, it is chiefly in the lower bed of red shale, for we subsequently found it there on the W. side of Pine Creek, nearly opposite Callahan's. At this spot it is not, however, well exposed, being only about 6 inches thick, and composed of hollow elliptical nodules, containing sometimes an undecomposed blue centre.

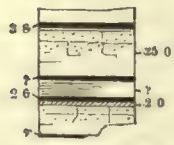


Fig. 348.—Otter's Run.

Tome's Creek enters Pine Creek on its W. side, heading near the corner of Lycoming County. The anticlinal axis N. of the Coal-basin we have been describing crosses the main creek just above their junction. Ascending the mountain by a road crossing over to the Coudersport Road, the Ponent rocks show themselves for the first two-thirds of the way up. Near the top of the formation we meet with two beds of the *blue calcareous*

conglomerate, and another about 100 feet higher up, among the lower beds of the Vespertine series, which continues for 100 feet more. Above this we find a bed of iron ore in the Umbral shales, at one time dug in several places: it varies in thickness from 2 to 3 feet. From the iron ore to the top of the hill—a vertical space of 40 feet—the rock is the white Seral conglomeritic sandstone, presenting at the summit may pebbles.

CHAPTER III.

THE THIRD COAL-BASIN WESTWARD TO PINE CREEK.

THE next Coal-basin towards the N., or the third in order, is that of Blossburg, on the Tioga River.

The hills on the S. side of the river, for a few miles above Blossburg, are capped by the conglomerate; the Umbral red-shale rocks come out on their S. slopes, the dip to the N. being considerable. No coal has been found on that side of the river, excepting near Blossburg, though it may possibly exist S. of the valley, near its source. The coal-formation extends E. nearly to the head-waters of Tioga River, but has not the thickness which it attains farther W.

On a stream called Little Falls Run, 9 miles above Blossburg, openings were made some years ago, under the direction of one of the mining companies of Blossburg, which developed a seam of coal about 3 feet thick, and some small bands of iron ore. A bed of conglomerate, 20 feet thick, occurs here between the layers of slaty sandstone, dividing this last rock into two portions: the lower is of considerable thickness; the upper one sustains the seam of coal.

Above the coal rests a bed of black shale nearly 20 feet thick, containing *kidney-formed iron-ore* of excellent quality, though not abundant, above which are three layers of a poorer species of iron ore in flat slabs, measuring 4 inches in thickness. Over the shale with ore lies a bed of slaty sandstone, extending to the summit of the hill.

The dip of the beds at this place is towards the N. At the E. side of this hill the sandstone which forms the summit contains some small pebbles, and somewhat resembles a conglomerate: it includes, also, some small bands of coal.

The next stream towards the W., which furnishes a good view of the strata, is Fellow's Run; but no coal has been opened upon it. About three miles above its mouth this stream forms, by three bold leaps, a cataract of 60 feet in depth. Below the lowest of these, the conglomerate and sandstone rock rises in perpendicular walls to the height of the top of the waterfall, or to a level of 430 feet above the bridge at Blossburg; while the elevation of the same on Morris's Run, lying farther W., is about 300 feet.

The following section of the strata at Morris's Run was furnished by Mr Young:—

	Feet.	In.
Coal, all good,	4	0
Sandstone, somewhat pebbly,	8—10	0
Shales, with balls of iron ore,	4—5	0
White and grey sandstone,	6—8	0
Bituminous slate,	1	3
Coal,	1	5
Bituminous slate,	2	6
Coal,	0	2
Slate and sandstone,	16	0
Coal, resting on fire-clay,	1	4
Slate,	3	0
Slate, with balls of ore,	4	0
Strong slate,	10	0
Coal, in two benches,	5 ft. 6 in. to 6	0
Slate and fire-clay, with 8 inches coal in middle,	16	0
Coal,	3—5	0
Pebbly sandstone,	40	0
Shale,	1	0
Coal,	16 in. to 1	6
Slate,	1	0
Coal,	0	15
Slate,	15—20	0
Conglomerate,	6	0
Iron shale, with very little ore,	3	0
Coal,	0	10
Clay-slate,	6	0
Green sandstone,	15	0
Red shale or marl,	30—35	0
Sandstone, with 3 feet of sandy limestone.		

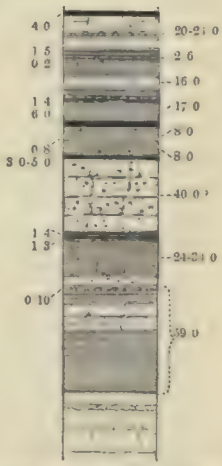


FIG. 349.—Morris's Run Strata, near Blossburg. 1 *inch* = 100 *feet.*

The highest Coal-measures in the Blossburg Basin lie between Morris and Coal Runs, and are 165 feet above the Blossburg Main Coal; but at Blossburg the highest stratum is about 120 feet above that bed. The capping rock here, at Morris's Run, is a pebbly sandstone.

It will be observed that there is some want of harmony between the preceding Section and the following, representing the stratification at *Blossburg*, for which we are indebted to Messrs Humphreys and John Evans. The main beds of coal are, however, the same;—

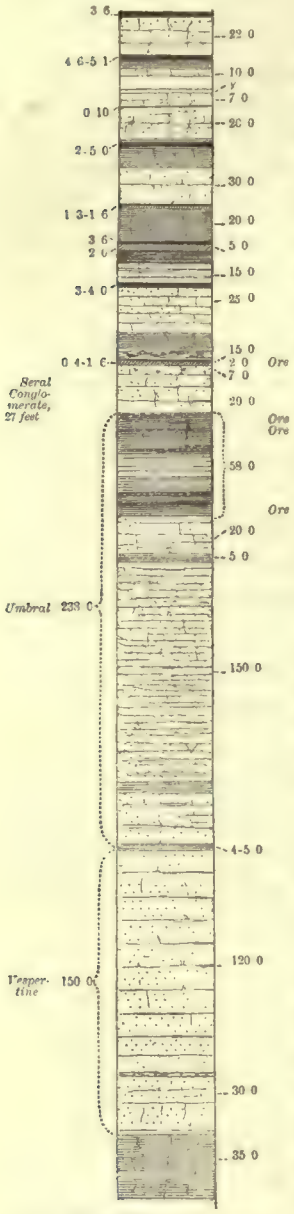


FIG. 350.—Blossburg Strata. 1 *inch* = 200 *feet*.

	Feet.	In.
Coal, all good,	3	6
Space,	22	0
Coal, 3 feet 6 inches, good,	4½—5	0
Slate and Sandstone,	10	0
—— blank.		
Pebbly sandstone,	7	0
Coal,	0	10
Sandstone,	20	0
Coal, dirty,	2—5	0
Slate and sandstone,	30	0
Coal, 1 foot 3 in. to	1	6
Fire-clay,	3	0
Slate,	20	0
Coal, 3 feet, good, the Morris Bed,	3	6
Fire-clay,	4—6	0
Coal,	2	0
Argillaceous sandstone and slate, with two thin coals,	12—15	0
Coal, thickest at Bear Creek,	3—4	0
Micaceous sandstone, thin-bedded,	25	0
Shale, with 1 foot kidney ore,	15	0
Coal, kidney bed, 4 in. to	1	6
Impure fire-clay,	2	0

	Feet.	In.
Pea-conglomerate,	7	0
White sandstone, in part suitable for making glass,	20	0
Shales, with lean oolitic ore,	1	6
Ore,	1½—2	0
Red and mottled shale,	6	0
Ore,	0	6
Shale,	10	0
Shale, with coarse nodular ore,	2	0
Argillaceous sandstone and slate,	20	0
Shale, with 18 inches of grey ore,	4	0
Slate, with 7 inches of ore,	6	0
Slate,	6	0
Dark brown micaceous sandstone,	20	0
Red shale and green slate,	5	0
Greenish grey sandstone to level of railroad,	150	0
Red shale, about	4—5	0
Vespertine sandstone, calcareous bed 30 feet from bottom,	150	0
Red shale and marl,	30—35	0
Green flaggy sandstone.		

As some anticipations exist that the coal will be developed in Elk Mountain, the S. margin of the basin, it may be desirable to present in this place a general description of its summit.

Near the top of a high ridge between the forks of Carpenter's Run, a tributary of the Tioga from the S., occurs a stratum of fine-grained white sandstone, which readily disintegrates into good glass-maker's sand. Below this we meet many loose pieces of conglomerate, which occurs in place 100 feet higher up, constituting benches within 50 feet of the summit, and about 500 feet above the Tioga River. This rock is about 50 feet in thickness, being in some places a coarse conglomerate, in others passing into sandstone; it caps the whole ridge opposite the mouth of Fellow's Run, for a mile or more back from the river. Its dip is towards the N.N.W. The same rock has been encountered farther E. on the same side of the Tioga, forming the summit of the hills. It is in vain, therefore, to look for workable coal in these positions; the most that can be hoped for being a small imperfect seam, about 10 inches thick, which is occasionally found beneath the stratum.

The rocks in the bottom lands along the river above Blossburg belong to the Vespertine series, and contain some layers suitable for whetstones. The Ponent rocks do not show themselves.

Coal Run, upon which some of the mines above Blossburg are situated, enters the Tioga from the N.E. Its

source is not quite a mile from the river. The hills around it are 400 feet above Blossburg. A nearly continuous section of the strata was obtained on this run. The highest bed measured is at an elevation of about 284 feet above the river, above which occurs a considerable thickness of rocks without exposures. The section (see Fig. 351) is as follows:—

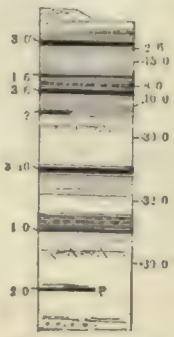


FIG. 351.—Coal Run.

Brown sandstone, with kidney ore shut out by the sandstone; shelly, thin. *Coal*, chiefly cannel, 3 feet; fire-clay, 2½ feet; shale, 15 feet. *Coal* (the fire-clay coal), 18 inches; fire-clay, 2½ feet; shale, 2 feet; nodular ore band, 4 inches; shale, 3 feet. *Coal*, 3½ feet (the Morris Coal); fire-clay, 2½ feet slate, 10 feet. Sandstone, vegetable remains, 30 feet; fire-clay, 6 inches. *Coal*, cannel (including two seams of slate 12 and 3 inches thick), 3 feet 10 inches. Shale, with rich kidney ore (aggregate thickness, 6 inches in 3 feet of shale), 32 feet. *Coal*, too far below the ore to be worked with it, 1 foot; this is the kidney coal. Sandstone, 30 feet. *Coal*, cannel, 2 feet; Olive shales, thickness unknown. Sandstone, with vegetable remains, passing downwards into conglomerate. Then the Vespertine red shales are seen alternating with sandstone strata.

The difficulty of identifying the beds already noticed with any in the column here given, in the absence of all traces of calcareous strata, will be at once apparent.

The beds of the next section (Fig. 352) are not open to the same indefiniteness as to stratigraphical position; they evidently coincide with those in the Towanda, Otter Run, and Morris Run.

Coal is obtained on Bear Creek, North of Coal Run, on the same side of the river. A thick bed of sandstone, part of which is pebbly and about 50 feet thick, forms the upper part of the hill, under which we have, after a few feet of intervening unknown rocks,

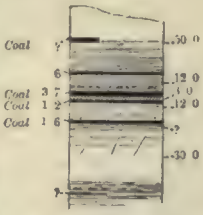


FIG. 352.—Bear Creek.

Coal, variable, sometimes 1-foot shale, embracing 4 inches of iron ore, 10 to 12 feet. *Coal*, 3 feet 7 inches; fire-clay, 2 to 3 feet; *Coal*, lower half cannel, 14 inches; dark sandstone, 12 feet. *Coal*, 1½ feet. Interval. Sandstone, imbedding pebbles, 30 feet. Shale, 3 to 4 feet, containing iron ore. Sandstone, conglomerate; Umbral shales.

The upper coal occurs on the South side of the creek, where it is 1 foot 6 inches thick; but on the North side it is entirely wanting. The ore in the next stratum is good, but small in quantity; this bed is also visible on Coal Run. The next bed is the main coal-seam of Blossburg; it has been opened in five different drifts, two on the South side and three on the North side of the creek, at an elevation of about 280 feet above the railroad, not quite a mile distant. The quality of this coal is somewhat injured by the amount of sulphuret of iron occasionally present, from which, however, the chief part of the bed is comparatively free, having a fine brilliant lustre. A fault, crossing the three drifts on the North side of the creek in a N.E. and S.W. course, throws down the coal 3 feet. Large quantities of this coal are carried down the Tioga valley in the winter. The fire-clay under this coal contains *Stigmaria ficoides*. At its outcrop occurs a large deposit of exceedingly tough clay derived from this bed, well adapted for the manufacture of fire-bricks.

The 18-inch seam of coal has been partially mined. The sandstone which underlies it is rather remarkable, passing in its lower bed into a coarse conglomerate.

Under the latter lies another sandstone, and beneath that the Umbral red shale.

Beneath the Seral conglomerate a band of iron ore was struck, which upon being pursued into the hill thinned entirely away. Its appearance justifies further exploration.

The shale containing this ore is nearly 5 feet thick; at its outcrop the ore consists largely of long elliptical balls of a very argillaceous brown ore, lying closely adjacent to each other, and forming more than one-half of the stratum. Each elongated nodule exhibits externally a series of concentric crusts, which readily peel off by exposure to the atmosphere. Beneath the balls lies a nearly solid layer of a heavy yellowish-grey ore, about 6 inches thick, having a true oolitic structure. These beds appear to be shut out by the overhanging sandstone at a short distance from the surface. Other excavations have been made for ore in the other red bands lower down in the series, but unsuccessfully. The conglomerate and sandstone of the two beds described, strew the hill-sides in great quantity, and furnish an excellent building-material.

Half a mile N. of Bear Creek, and parallel with it, is the denuded valley of East Creek, on the N. side of which the hill is capped by a thick bed of sandstone passing towards its lower part into a conglomerate. Underneath this lies a stratum of brown shale, 15 feet thick, containing four bands of nodular ore, included in a thickness of 7 feet of shale, the aggregate thickness of the ore being 13 inches. This bed of ore is the most promising hitherto met with in the region. The chemical composition of the ore we may hereafter furnish.

Below the shale is a thin layer of sandstone; then a black shale, including a thin seam of cannel coal; and 15 feet under this, another seam of ore 15 inches thick, it is said, occurs; and beneath it again a bed of coal 21 inches in thickness.

A considerable S. dip occurring between East Creek Hill and Bear Creek Hill, the sandstone capping the summit of the former, is probably the same as that which underlies the coal-openings along the latter. On Limestone Hill, half a mile further N., the highest rocks are the thin-bedded Vespertine sandstones extending from within 200 feet of the base to the summit. At its base the limestone so often found at the alternation of the Ponent and Vespertine series, shows itself with a thickness of at least 8 feet, consisting of heterogeneous materials, closely cemented by calcareous matter. It has a variegated aspect, like certain *breccias*. It is a durable rock, well adapted for building-stone, but is too impure to be converted into lime. It is underlaid by a bluish micaceous sandstone, furnishing an excellent building-stone. The dip here is at an angle of 5° towards the S.S.E.

North of Limestone Hill, some of the lower layers of the Ponent series appear above the bed of the valley. In one particular band of red micaceous sandstone occur numerous mutilated remains of a highly curious fossil fish, the *Holoptychius*. Further N., still lower rocks appear.

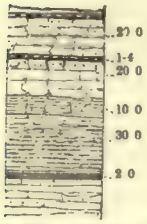


Fig. 353.—Blossburg Vespertine and Ponent.—1 *inch* = 100 *feet*.

The following section exhibits the alternation of Vespertine and Ponent strata, displayed at Blossburg:—

Brown concretionary calcareous Conglomerate, 0; Greenish-greyflaggy Sandstone, 20 feet; Brecciated or lower calcareous Conglomerate, 1 to 4 feet; Greenish and bluish-grey micaceous Sandstone, 20 feet; Red Marl, streaked with blue blotches, 10 feet; Red marly Shale, 30 feet; Grey micaceous sandy Slate, 2 feet; Greenish-grey micaceous Sandstone, 0.

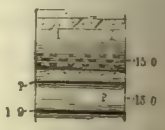


Fig. 354.—East Creek.

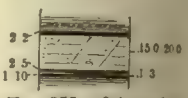


Fig. 355.—Johnson's Creek.

The plane of contact of the Vespertine and Ponent strata rises N. 350 feet to the mile.

On the W. side of the Tioga River, between the heads of Johnson's Creek and Boon's Creek, 3 miles from Blossburg, the Coal-measures occupy the hills, though little is known of them at this locality. The following account of the stratification on Johnson's Creek was furnished by the superintendent of the mines at Blossburg.

Near the summit occurs a shale containing nodular iron-ore; below this, a bed of coal 2 feet 2 inches thick; then 15 or 20 feet of sandstone; then another coal-seam embracing 2 feet 5 inches of coal, 15 inches slate, and 22 inches coal,—in all, a bed about 6 feet in thickness.—(See Fig. 355.)

On West Hill, near the mouth of Johnson's Creek, there is a sandstone passing into fine-grained conglomerate about 50 feet in thickness, underlaid by 4 feet of olive-coloured shale, containing about 2 feet in the aggregate of *iron ore* near its outcrop. The lower portion of this ore is of a greenish-grey colour; the upper is reddish, and sometimes oolitic in its structure. At the outcrop the greenish-grey kind is 1 foot 4 inches thick, the red ore 9 inches. The whole bed shows signs of diminishing in thickness when followed in towards the hill, but possibly it may again augment. At the foot of the hill a considerable deposit of *bog ore* has been collected, apparently from this stratum.

Crossing this coal-basin at a point further W., in a S.E. direction from the S.W. corner of Charleston Township, the following features present themselves: The hills in this part of the township are capped by the Seral conglomerate, the material used in the construction of the Court-house at Wellsborough. Passing S.E., crossing the forks of the First Fork or Babb's Creek, the conglomerate is seen to occupy the tops of all the high ridges, being nowhere met with below the summits. The upturned roots of the trees furnish no indications of coal smut. S. to the head-waters of the First Fork, near the Blossburg Road, the conglomerate caps the

summits. In so wild a country it is impossible always to pronounce with positiveness upon the non-existence of coal in a part of a basin like this, where a slight dip may bring in, unperceived, the lower part of the Coal-measures. This neighbourhood was carefully examined, and if the coal does prevail, it cannot cover much extent. Further W. the Coal-measures have been discovered across Wilson's or Yarnall's Creek entering the First Fork at Babb's, and heading towards Wellsborough, and the coal opened on the W. side of the stream. On the E. or opposite side, coal smut was also found by us at the mouth of Wilson's Creek. The dip is gently N.; and about 5 miles above or towards the N. it is S., forming the basin, in the centre of which lie these insulated patches of Coal-measures. The tops of the hills at the two boundaries mentioned consist of the conglomerate, or the brown rock above it, on the very highest knobs, gradually descending to a rather lower level in the basin, they have over them for a considerable extent of surface a moderate thickness of strata, which may be found to contain one seam of coal.

Between 100 and 200 feet below the conglomerate there occur abundant signs of a bed of iron ore, visible along the brow of the hills on each side of Wilson's Creek. Some amount of excavation, however, would be requisite to develop it. Along Wilson's Creek the Vespertine series is not very thick—the hills containing the Coal-measures being apparently not more than 600 feet high, while the Ponent red shales just appear above the bed of the valley.

The coal occurs between 2 and 3 miles above Babb's, at the mouth of Wilson's Creek. It overlies a bed of sandstone reposing above the conglomerate. The floor of the coal is a dark brown shale. The seam is double, the upper portion being 1 foot in thickness, the lower, 18 inches, both of good quality. They are separated by a band of dark shale 1 foot in thickness; the roof of the coal-bed consists of black shale full of vegetable fossils. The hill rises only about 30 feet higher than the level of the coal, and presented no indications of another seam, or of a band of iron ore, though much search was made.

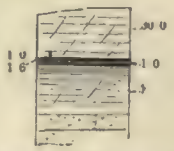


FIG. 356.—Wilson's Creek.

Half a mile N. from the opening made in the coal, the conglomerate rock is finely exposed, exhibiting itself in a bed about 35 feet thick. Receding a little from the front of the hill, a bench rises about thirty feet from the conglomerate. On the top of this flat the upturned roots of the fallen trees disclose numerous fragments of iron ore. The indications of ore are tolerably abundant from this point across to the Stony Fork, and the smut of the coal is also traceable throughout the same tract; but whether more than one coal-bed occurs, cannot be ascertained without much excavation. The conglomerate lies high, but some points of the surface tower a little above it. The outline of these high lands is undulating, the growth is open, and would furnish much timber adapted for making charcoal. On both sides of the Stony Fork the conglomerate crowns most of the hills until we advance several miles up the stream, where the lower rocks form the surface. This formation is well exposed in this vicinity, forming often an irregular line of escarpment around the brow of the hill for many miles in extent, where enormous blocks, dislodged from the stratum, open lanes and passages between them and the main bed.

In the bed of the valley of Stony Fork, the impure calcareous rock near the top of the Ponent series sometimes shows itself. About 3 miles from the mouth on the E. side, a very ferruginous spring appears, depositing a large mass of brown ochre. A little above this spring an excavation was made in search of ore, and a band of small compact nodules, whitish within and coated with a brown crust, was found imbedded in a shale. After penetrating to a depth of a foot and a half, a copious influx of water arrested the digging. This band of ore is conceived to be a continuation of that already discovered in so many places in the Umbral red shales. The same band was found some years since, several miles to the W., on Pine Creek. On the W side of Stony Fork the red shale below the conglomerate is very ferruginous.

Between the layers of the conglomerate, and but a short distance from the bottom, was found a thin band of black shale, readily mistaken at first for the outcrop of a seam of coal. As it is somewhat continuous, though only 1 foot thick, it is desirable thus to mention its position, corresponding as it does with the small seam of coal everywhere underlying the conglomerate, and representing at this great distance E. the Sharon series of Mercer and Fayette counties to the W. and S.

Over the conglomerate on the same side of the stream, the ground rising 20 or 30 feet, a few pieces of kidney ore were discovered. Upon trial, the bed, however, proved to be thin and irregular, being a band in the brown sandstone. Signs of the same seam were met with in other places, in a corresponding position in the strata, but they nowhere gave promise of being productive.

At the mouth of the Second Fork of Pine Creek, the rocks dipping gently to the N., the Ponent series extends from the bed of the valley a considerable way up the hills, the conglomerate capping only the highest knobs, and no Coal-measures appearing above this along Pine Creek. The only chance we have of finding them is above the head of Elk Run, which enters Pine Creek a mile and a half above the mouth of the Second Fork. Here a bed of iron ore was opened a few years ago below the conglomerate, being probably the same found upon Stony Fork. It was mined for a short distance in, by a regular drift, and proved to be between 3 and 4 feet in thickness; the whole of which, however, is not ore, a portion consisting of imbedding shale.

On Big Pine Creek, about 4 miles above the mouth of the Second Fork, the rocks, previously nearly horizontal, dip S., bringing in the conglomerate on the summits of the hills, about 2 miles below this place on the E. side of the stream. This very shallow basin in the rocks will therefore, probably, not yield any coal along Pine Creek.

CHAPTER IV.

THE FOURTH BASIN WESTWARD TO PINE CREEK.

THE third axis, which crosses the Tioga River between Covington and Mansfield, traverses the middle of the Wellsborough Valley as far as the Round Islands where it crosses Pine Creek. The Wellsborough Valley, as here referred to, includes not merely that lying under our view as we look down from the hill-top, one mile from the village on the Covington Road, but also the whole tract of hilly land, and bottom, about 10 miles wide, which lies between this ridge and the mountain plateau of the coal-basin on the N., now to be described. This interval is composed of the upper 300 feet of the Vergent series, some layers of which, particularly those adjoining the stratum of limestone above mentioned, are very rich in fossils. These rocks are thrown into a broad arch by the third great axis of the region. The hills lying at the base of the two mountain-ranges on the opposite sides of the valley, are composed in part of Ponent rocks, and show this formation much thinner on the N. than on the S. side of the valley: its precise thickness could be readily obtained; but a mile N. of Wellsborough it was not supposed to exceed 100 feet.

The Vergent series is not extensively developed where this axis crosses Pine Creek, and a satisfactory reason may be had by observing the W. dip of the axis itself. A few miles from Covington, distant about half a mile S. of the road, the top and sides of a hill, by their peculiarly regular and well-marked slopes and bends, show the dip without need of exposures. It plainly exhibits the dip of the strata within it to be about 70° W. by S. This hill is nearly upon the summit-line of the axis. Were it to continue W. with no modification or irregularity, the geographical level of two points on the same geological level would vary by nearly 10,000 feet. We must therefore conclude that at this point the axis has a sudden flexure downward to the W., while the superior height of the Vergent rocks upon Tioga River, above that which they attain on Pine Creek, proves that the axis, on the whole, slopes several hundred feet to the W. in that distance.

From the hills affording the view of Wellsborough above mentioned, facing N., one may discern a range of very high land, ranging at the nearest point within 5 or 6 miles of the point of view, and opened by three conspicuous gaps. One of these is that of the Tioga River; a few miles W. is a double one; and the third marks the issue of the Big Marsh Creek. The mountain is seen to continue to the W. of the latter along the N. side of Pine Creek, and is still cut transversely at intervals by the N. smaller tributaries of that stream.

From one of the hills, a few miles S. of the Cowanesque, we see looking S. the N. border of this same mountain-range; it is equally straight and regular in its summit outline, and gapped in fewer places. This mountain-chain is 6 or 8 miles broad, like the others already described, and is not only split down lengthwise to

its base by Crooked Creek, but deeply furrowed by dozens of its tiny branches and their water-courses. This is one of the most curious facts observable in Tioga County, and well illustrates the influence of its geology upon the topography of the country. Not only do most of the streams head upon Axis No. 3, and flow N. to Big Marsh and Crooked creeks, and S. to the Second Fork, but in the valley N. of the mountain-chain,—we here mean the valley through which Axis No. 5 runs,—the streams head on that axis also, and flow down the N. and S. slopes into Crooked and Pine creeks and the Cowanesque. And we may say that it is in obedience to this general law that Pine Creek, in the upper part of its course, flows E., that is, along the centre line of the Fourth Basin, and not S.

The only point where we found coal, and evidently the only place where there is any likelihood of finding it, is at a low knob upon the N. side of the mountain, 2 miles up the North Branch of Crooked Creek, above its forks, and 9 miles from Wellsborough.

Here is a coal-bed overlaid by 20 or 30 feet of sandstone, its outcrop describing a wide circle about half a mile in diameter. Its thickness is not known.

Westward of this, between Long Run and Big Marsh Creek, the top of the mountain is capped in many places by this same bed of coal, about 2 feet in thickness. The conglomerate in the first position (near Wellsborough) does not deserve that name; one passes it in going up to the coal, and only recognises it by the steeper slope which it causes, and its proximity to the coal. It is about 60 feet thick, fine in its texture, and is underlaid by red and green shale, without the appearance of iron-ore. It is possible, however, that this coal-bed may be the one that underlies the main Seral conglomerate, in which case the latter cannot be said to be present on the mountain.

Upon Pine Creek this rock is a coarse and true conglomerate, and appears in bulk upon most of the hills N. and S. of Pine Creek going W. This part of the basin could not be well explored, because of the extreme wildness of its state at present, and more labour and an expensive outlay of time did not seem to be demanded by the very inferior value of its economical geology. Only one seam of coal is likely to be found upon a few spots on its highest planes, and that one is seldom worth the working.

CHAPTER V.

THE FIFTH COAL-BASIN W. TO THE GENESEE RIVER.

Upon the highest knob of the low mountain-land which bounds the broad anticlinal valley of the Fourth Axis on the N., within sight from Knoxville (a little village upon the Cowanesque at the mouth of Troup's Run), there is a platform of whitish sandstone, covering perhaps 50 acres, and from 10 to 15 feet in height. This platform probably conceals, and has protected, a remnant of the lowest bed of coal—viz. that just described in the last chapter as in a similar position.

The Seral conglomerate appears only as a well-marked terrace of coarse white sandstone, passing insensibly downward into Vespertine grey sandstones, as do the latter into Vergent flaggy grey and olive sandstones.

Of the Umbral Red-shale ore no traces were here observed; but 7 miles W. of Knoxville, on the top of a hill on the S. side of the Cowanesque Creek, upon the road which leads over to Mixtown Settlement, large blocks of white sandstone assert the presence of the Seral conglomerate, and on the S. side of the hill appear red and variegated shales, with small pieces of iron ore of poor quality, and not in abundance. It was in descending this hill, among the outcrop fragments of the grey Vespertine rocks, that a fine fragment of *Holoptychius* was found.

About 8 miles N.W. from the Big Meadows occurs a bed of iron ore, from which a large deposit of brown ochre has been produced. Much ore has been taken from this spot. The ore-band has not been fully developed; it occurs within 100 feet of the summit of the hill, lying probably below the conglomerate, though that rock

does not appear. About 2 tons only of loose nodular ore have been excavated. 20 feet below this bed, a bench or broad terrace occupies the flank of the hill, embracing about 20 acres of surface; it is covered by a rich deposit of the bog-ore, to a depth averaging perhaps 2 feet. Higher on the hill a small seam of coal, 1 foot in thickness, occurs, which is of limited extent. Near the summit of the hill are indications of another bed of iron ore.

CHAPTER VI.

COUNTRY BETWEEN PINE CREEK AND THE SUSQUEHANNA WATERS.

THE great rolling plateau of the Alleghany Mountain, in which Pine Creek and the Susquehanna River, with its numerous branches, cut their way 1000 feet below its general surface, has not, until within a few years past, received any contributions from the foreign or domestic centres of emigration. It remains almost what it was a century ago, an unbroken forest, tenanted by the panther, bear, deer, wolf, and fox.

The soil is cold, but produces excellent wheat—not, however, in heavy crops. The grasses are the natural staple of the cleared bottom-lands of Pine Creek.

Across this region the Jersey Shore and Coudersport Turnpike passes, ascending its S. escarpment, where Pine Creek issues from it, 4 miles from Jersey Shore. The ascent is 2 miles long; the whole distance to Coudersport, about 80 miles. For 68 miles of this road, at the time of our last visit in 1846, the traveller passed the doors of only six houses, while thirteen other families resided at greater or less distances from it, in the forest to the right and left. Three of these were Irish settlers living at the head of Chatham's Run, and holding correspondence with the world through Jersey Shore. Four others, the extreme E. families of the settlement, were upon the S. Fork of Kettle Creek, a settlement numbering, in 1846, thirty-three families, and communicating, by canoe navigation, through an uninhabitable gorge of 8 miles, or by "Boon's Road," 14 miles across the mountain, with the main Susquehanna, above Young-Woman's Town. In such a country, with the small means at our command, little could be accomplished beyond merely noting the general phenomena, sufficiently indeed, as in the end appeared, to enable us to announce the economical value of its geological contents.

A low ridge, perhaps 100 feet in height, called the Sandstone Ridge, and ranging from the head of Queen's Run E., upon the general table-land, terminates with a beautiful rounded and terraced end, at the turnpike near M. Focht's house, 11 miles from Jersey Shore, and 5 miles back from the edge of the mountain, if measured diagonally along the turnpike. Here, upon the turnpike, and marked by the bench in the ridge's S. side, is the outcrop of what is probably the only coal-bed in the region. Its outcrop is repeatedly marked upon the turnpike between this place and Mr Hearod's old settlement, 23 miles farther on. It is always seen to be covered by reddish friable shales. In many places it appears to be rather two beds than a single one, separated by several feet of intermediate rocks.

Mr Hearod's tavern is situated in the Third Basin, and the coal, 1 foot thick, was once opened upon his land. It outcrops in a well-marked bench upon the road, 1 mile N. of his house. Here, as in many other places, the disintegration of the Seral conglomerate produces a fine white sand, well adapted to the purposes of the glass-maker. It is said that, in sinking the well at Mr Hearod's clearing, coal of good quality, and 3 feet thick, was struck at a depth of 20 feet below the surface. This would show its place to be from 40 to 50 feet above the conglomerate.

The turnpike enters Potter County at its S. corner, and leaves it at its N.W., not far from Olean Point or Hamilton Village, in the State of New York.

After passing the N. outcrop of Hearod's Coal-bed before mentioned, one passes 8 miles over Vespertine sandstones, and also flats covered with a reddish irony soil, doubtless due in some measure to the presence of Umbral red shales. All this distance the land is very high, and gently rolling; but now suddenly commences a deep descent to the bed of Kettle Creek, by the valley of one of its tributaries, which excellently illustrates the

sharp ploughing action of the denuding floods, which swept across the country, leaving it ravined and trenched as we see it.

The abrupt heading-up of such a valley upon the comparatively dead level of the table-land is remarkable, and may be compared with the ravines (on an infinitely smaller scale) effected in the soft banks of the streams of the sea-coast, by the yearly rain-drainage, wherever the cultivation of the soil had been neglected.

The third axis crosses the road between the forks of Kettle Creek, bringing in sight in its deep valley the upper rocks of the Vergent series.

After crossing the West Branch, the road rises again to the summit-level, and is made to follow for several miles the crest of a "hog-back," where the traveller looks right and left down two steep slopes into two parallel valleys, each many hundred feet below him. This is composed of Vespertine grey sandstone, excepting two long flats covered with the above-mentioned red soil, and two small unconnected patches of Seral conglomerate, which here seems to be a fine-grained white sandstone.

The conglomerate does not occur again on the road to Coudersport, although the latter keeps upon the high ground across the fourth axis, and into the Fifth Basin. There the road descends into the valley of the Alleghany River, where the upper mixed strata of the Vergent series appear upon it.

It will thus be seen that on this road there appears no sign of coal in the Fourth or Wellsborough Basin, although the mountains in that basin, at the elbow of Pine Creek, contain the lower bed, as does also the high land crossed by the road at Hearod's, in the next basin to the S. It remains yet to be seen if the coal appears where the basin is crossed by the Driftwood Branch of Sinnemahoning. The wildness of the country effectually prevented a nearer approach to certainty, though such might readily be obtained by a camping party.

CHAPTER VII.

FIRST BASIN TRACED FROM THE SUSQUEHANNA S. TO CAMBRIA COUNTY.

THE rocks along the Susquehanna River are the argillaceous sandstones forming the thick bands at the alternation of the Ponent and Vespertine series, dipping at a considerable angle to the N.W. At the mouth of Lick Run these give place to Vespertine rocks, having their usual character of a brown slaty sandstone, but containing a few bands of a silicious conglomerate, somewhat like the Seral conglomerate, though darker. Above this sandstone lie the Umbral red shales in two separate strata, alternating with a grey sandstone, referable either to the Vespertine or Seral series. The lowest of these red shales is a bed 65 feet in thickness, containing two seams of *iron ore:* one only about 6 inches thick; the other, 20 feet above it, being about 10 inches. The ore is apparently good, but probably not sufficiently abundant to be valuable.

A similar ore has been discovered on Queen's Run, 1½ miles N.E. of the Queen's Run Mines, where it promises a greater quantity. Between the two seams of ore occur buff-coloured and red shales. Overlying this red shale is a thick stratum of grey sandstone, analogous to the Vespertine grey sandstone, about 250 feet thick. This supports another thinner bed of Umbral red shale. At the mouth of Queen's Run the Vespertine sandstone contains a seam of fire-clay 4 or 5 feet thick, which is a little too sandy, but may be worth working, if mixed with a more argillaceous variety. At the mines on Lick Run the strata have been bored from the highest ground down to the upper bed of the red shale. At different points where this was done the strata do not precisely correspond. One of the most important of the beds, a seam of coal, is absent over a considerable extent owing to a dislocation in the strata, or to other causes not yet ascertained. In one of the knobs, where the position of the coal appears to be represented by slate and sandstone, we have the following section (see Fig. 357).

Soil, 21 inches. *Coal*, not under sufficient cover to be hard, 5 to 6 feet (here only 1½ feet). Fire-clay, 6¾ feet. Brown Slate, 5 feet. (*Coal* should here occur 19 feet beneath the brown slate, 6 feet thick, and containing 16 inches of

slate, but it is absent). Dark slates and flaggy sandstones, 76½ feet. *Coal*, 2 feet 4 inches. Dark slate, 9 feet 7 inches. *Coal*, 3½ to 5 feet.

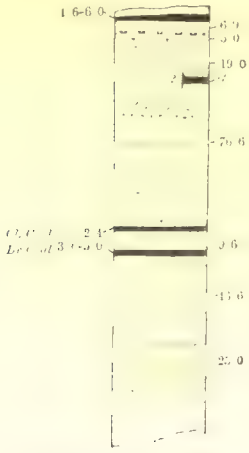


Fig. 357.—Lick Run, Farrandsville.

This is the lowest coal-bed of the basin, as it was mined by the Farrandsville Company for the use of their furnace, where it underwent the coking process without the aid of ovens. It was then sent by an inclined plane and railroad to the furnace at the base of the mountain. The second coal-seam in the ascending order was not worked, the coal being impure; but the third, where the ground is sufficiently elevated to embrace it, has been wrought to some extent, yielding a better coal than either of the other two. It is now, however, nearly exhausted. This upper coal-seam, lying usually near the surface of the highest ground, has generally an unsound roof, which unfits it to be mined. It measures commonly 6 feet in thickness. It is removed to expose the fire-clay which lies immediately beneath it, found to be of superior quality for the manufacture of fire-brick. This fire-clay, from 6 to 7 feet thick, is destitute of grit, and furnishes an admirable fire-brick. Under it lies a bed of shale, containing a layer of *nodular iron-ore* of no great purity or richness.

Beneath the lowest bed of coal slaty sandstone and shales occupy a thickness of 46½ feet, succeeded by 25 feet of red shales, this by upwards of 200 feet of grey sandstone, and this again by the lower bed of red shale. It is very remarkable that we nowhere find the rocks occupying the position of the Seral conglomerate, possessing the conglomerate character, while in every other neighbourhood in the same basin, as at the First Fork of Pine Creek and on the Tangascootac, as we shall show hereafter, this rock exists in its true type and features.

At Queen's Run the same beds of coal and fire-clay occur which we see at Farrandsville, with this difference that the uppermost coal-seam is there under an ample covering, and ranges over a tolerably extensive surface, being the only bed at present mined. Its thickness varies from 5 feet to 3 feet 9 inches. The coal is superior, and finds a ready market along the Susquehanna.

The *fire-clay* at this place is occasionally 8 feet thick. A bed of coal about 4½ feet thick occurs not far beneath it. This does not appear in the Coal-measures above Farrandsville. The other beds in the series are supposed to occur here, though their existence has not been positively ascertained. At the mouth of Queen's Run fire-bricks have been made to a moderate amount, and at Farrandsville on a more extensive scale.

The smelting furnace at Farrandsville is built of stone, lined with the fire-brick; it is 54 feet high. The diameter of the boshes was originally 17 feet, but was reduced to 13. A powerful steam-engine having 10 boilers, and estimated at 170 horse-power, when all are in action, propelled the blast. From the description given of the Coal-measures of Farrandsville, it would appear that they furnish neither iron ore nor limestone; hence the ore used in this furnace was brought from Montour's Ridge in Columbia County, being the fossiliferous ore of the Surgent shales. An inferior species was also procured on Larry's Creek from the lower beds of the Ponent series; the former was transported about 100 miles, the latter 23 miles. Limestone from Nittany Valley was used as a flux. The proportions of the materials employed in making one ton of cast-iron, in October 1839, were as follows:—

Coke, 6500 hogsheads, 2900 tons; Fossiliferous Ore, 3200 hgds., 1428 tons; Larry Creek Ore, 3500 hgds., 1562 tons; Limestone, 4500 hgds., 2009 tons.

After the furnace had been in blast some time the cast-iron produced was of a superior quality as a foundry iron, and the yield was about 50 tons per week.

The extreme horizontality of the rocks observable in ascending the Susquehanna from Queen's Run, is undoubtedly due to the dying down of one of the broad axes of Tombs' Run Valley, which crosses Pine Creek about 7 miles above its mouth, and passes under the turnpike W.

Tangascootac.—Passing to the W. side of the Susquehanna, the Coal-measures next appear on the Alleghany Mountain, on the S. side of the Tangascootac Creek. This stream runs nearly centrally along the basin

for 5 miles, with a margin of comparatively broad and regular bottom-lands on each side. Owing to the greater amount of denudation in the lower part of the valley, the Coal-measures do not there occur; but higher up they expand over a considerable extent of country, and acquire a thickness of several hundred feet. The forest growth near the S. Fork is open, consisting of fine hard wood and scattering white pines, and the surface changes from the steep mountain acclivities seen nearer the river, to gently-rolling hills and extensive plains. The rocks along the valley of the Susquehanna for about 6 miles belong exclusively to the Vespertine series. At the mouth of the creek this formation rises nearly to the top of the Alleghany Mountain, and caps the hill on the N. side of the stream. The first appearance of conglomerate is where it covers the E. extremity of the Alleghany Mountain. Tracing it W. it gradually comes in at a greater distance below the summit, until, 3 miles from the river, the Coal-measures occupy the mountain-top, and the white pebbly sandstone of the Seral conglomerate lies under the summit, and crops out high up on the S. side.

The hills on the N. side of the Tangascootac do not reach the elevation of the Alleghany Mountain until we advance N. several miles, when a change of the dip to the S. brings up the lower rocks, but with an extremely gentle dip. Along the N. side of the creek the knobs are capped by Seral conglomerate as far up the valley as the forks. A little below this the Coal-measures first appear on the N. side of the stream, and finally, farther towards the W., they occupy all the high ground between the heads of the two forks, but no coal occurs to the N. of the North Fork, the hills there being capped by the conglomerate.

The most eastern coal-beds opened are S. of the First Fork, at an elevation of about 530 feet above the stream, which, in the course of 2½ miles to its mouth, descends 30 feet. The upper bed lies beneath a thick stratum of brown sandstone. It appears to be 4 feet thick, but at some distance in from the outcrop a fault causes it locally to be only 2 feet. The quality of this coal is excellent; it is underlaid by a bed of good fire-clay. There occur about 35 feet of other strata covering this bed over an area of perhaps 50 acres.

Another coal-seam, somewhat slaty, 3 feet in thickness, lies about 30 feet lower down, at no great distance under which is the conglomerate, forming a stratum nearly 100 feet in depth. This rock is here a fine sandstone, containing white pebbles, and disintegrates into a fine sand, well adapted for making glass.

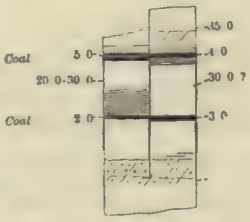


Fig. 358.—Tangascootac Creek.

The next openings are on the S. side of the creek, two miles above the forks. The upper bed occurs near the top of the hill; it is 4 feet thick, including some small seams of slate and fire-clay. Over it lies a soft and very tenacious slate-clay, 4 feet thick. The coal is good; it breaks into rectangular pieces, and contains much mineral charcoal, occasionally in seams nearly half an inch in thickness, showing the fibrous structure of the coal vegetation. It is beautifully marked by thin alternating lamina of dull splint and splendent glance coal. A bed, supposed to be the same, has been opened at a lower level in a N.W. direction, that being the course of the dip. At this latter place its total thickness is 4 or 5 feet, including 1 foot of dividing fire-clay.

Between 20 and 30 feet under this occurs another coal-seam, not well exposed, but apparently 2 feet thick; upon it rests 2 feet of fire-clay, and over that 1 foot of black slate, surmounted by more than 10 feet of blue slate. The rocks underneath the coal are entirely concealed, but the conglomerate cannot be far below.

On the S. side of the Alleghany Mountain there are two small *benches* near the summit, at some height above the steep slope, caused by the conglomerate. The lower of these contains the "brown rock," while the upper one probably embraces a bed of coal.

The hills N. of the North Fork constitute the N. margin of this coal-basin. They are higher than the hills around, being capped by the conglomerate. Between the N. and S. forks Coal-measures extend through the hills for some distance. Indications of *iron ore* present themselves in the Umbral Red Shales, in a ravine 2 miles above the forks. Between 5 and 6 miles from the mouth, the Coal-measures are within 75 feet of the beds of the streams, the hills rising about 250 feet higher. Further W., the surface becomes smoother, and the extent of country embracing the Coal-measures much greater. The distance across the basin, from the Alleghany Mountain to the hills N. of the North Fork, is apparently about 5 miles, but the actual area of the

coal is more circumscribed, owing to the numerous valleys of denudation. In the district described, the indications of iron ore among the Coal-measures are unpromising.

This basin is prolonged across the head-streams of Beech Creek, and embraces the Coal-measures at Snowshoe and Philipsburg, which will now be considered, premising that, where the waters of Beech Creek interlock with those of Tangascootac, we find that the Coal-measures, hitherto forming a narrow strip along the S. Branch of the Tangascootac, gradually widen and recede from the mountain as we trace them towards the S.W. As the main stream of Beech Creek flows close to the N.W. foot of the mountain, we meet with none of the productive Coal-measures immediately on either side; its hills consisting of the sandstones of the Seral conglomerate, no coal nor any indications of it could be detected. The nearest outcrop of a coal-seam is one which occurs a little N. of the turnpike, and which is about 4 miles N.W. of the E. summit of the mountain. This coal lies between 60 and 70 feet above the top of the silicious conglomerate. The bed is 4 feet 4 inches thick, and contains a thin seam of slate. The coal, which is good, has been mined to some extent. It may be traced over a considerable range of country, by a bench or little terrace, which marks its outcrop near the summits of the hills. This indentation near the tops of the hills, rising and becoming indistinct at the edge of the coal-basin, disappears entirely about $1\frac{1}{2}$ miles E.N.E. of Snowshoe. Three quarters of a mile N. of the spots where the coal is opened, we discern the smut, which marks the outcrop of the coal at "Lucas's Sugar Camp," where an excavation, formerly made, has now caved in, hiding the thickness of the coal. The report throughout the neighbourhood is, that the bed is 9 feet thick, and contains a band of clay 3 inches thick.

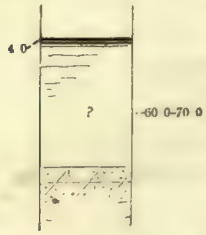


FIG. 359.—Beech Creek.

FIG. 360.—Snowshoe.

At the principal mine, which is on the turnpike, the coal-bed is 6 feet thick, including a layer of cannel coal, 6 inches thick, which runs through the middle. The roof here is also of slaty cannel coal, the body of the seam being, however, a beautifully brilliant and pure glance-coal, eminently suited to gas-making. It has a very sensible dip, inclining at an angle of several degrees, and to an unusual quarter, the N.E. and N. During the winter months coal in considerable quantity is transported from this mine to the country E. of the Alleghany Mountain. It is quite probable there may be one or two coal-seams beneath the main coal.

Overlying the seam just described, we find, where the hills are high enough, another bench or indentation, marking a coal-seam, between 20 and 30 feet above the former. This coal appears to be thin and unpromising. Iron ore, though in small quantity, occurs in a bed of brown shale beneath the first or lower coal-seam. This district is now about to be fully developed under the auspices of a Philadelphia Company.

In the country extending many miles N.E. from Snowshoe, we find a range of "highlands" along the heads of the N.W. Branches of Beech Creek, where the rocks next beneath the Coal-measures occupy the entire surface. These owe their elevation to the range of the first axis W. of the Alleghany Mountain. Like the rest of the high belts between the coal-basins, the surface of this region is rugged and stony, and ill adapted to tillage, while it is wholly worthless in mineral productions. The iron ore appertaining to the Umbral Red Shale may be met with in its usual position, just below the conglomerate, but possesses little value in a country so wild and destitute of coal. Indications of this ore appear in springs, depositing much bog-ore in a more accessible region lying S. of the turnpike. These occur between the two branches of the Moshannon, on the line separating the lands of Jacob Gratz, Esq., from those of the Portland Lumber Company, and again about a mile up the Big Moshannon, S. of the point where the "Indian Path" crosses it.

In this neighbourhood, the first coal which shows itself, as we pass W. from the ridge of the Alleghany, occurs in the hills along the Indian Path, near the mouth of the Little Moshannon. Two benches, marking two different coal-seams, were traced along these hills. Descending to the Little Moshannon, we meet the "brown rock," or the sandstone below the lowest coal-seam, finely exposed in the steep hill-slopes; and just beneath this, the coarser beds of the Seral conglomerate. The strata here dip 4° to the N.E. Indications of two good coal-beds were met with, where the "Indian Path" diverges from the Karthaus Road.

From a little above the mouth of the Little Moshannon, nearly to Philipsburg, no coal was discovered along

the S.E. side of the Main or Big Moshannon, but at Philipsburg and S., up Cold Stream, coal occurs abundantly to within 1½ miles of the E. crest of the mountain. Six miles N.E. of Philipsburg there are indications of the Umbral ore upon the turnpike near the Moshannon; it lies under the coarse sandstone of the Seral conglomerate, which here constitutes the principal part of the hills. This ore is deserving of thorough investigation. Below this, on the Creek, springs depositing bog-ore are frequent. The red shale forms the bottom of the valley of the Little Moshannon near its mouth.

Philipsburg.—The principal mines wrought in the valuable district around Philipsburg are on the N. side of the Moshannon, opposite the village. The following section, compiled from measurements obtained at the spot, will show the number and relative position of the several beds:—

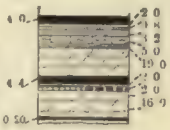


FIG. 361.—Moshannon, Philipsburg.

Covering rocks, thickness not great; Coal, 4 feet; Fire-clay, 2 feet; Calcareous Slate, 8 inches; Blue compact Shale, or indurated clay, 14 inches; Ferruginous Shale, 2 feet; Limestone, blue, ferruginous, 5 feet; Sandstone and Slate, 19 feet; Coal, good, 4 feet 4 inches; Fire-clay, 2 feet; Limestone, ferruginous, passing into iron ore, 2 feet; Sandstone, 16 feet; Coal, in Creek bed, 20 inches.—(See Fig. 361.)

The middle coal-seam, represented in the above section, the only one now wrought, is mined to a considerable extent. It is 4 feet 4 inches thick, is of sound texture and excellent quality throughout, and will afford solid blocks of coal the whole thickness of the bed, and as much as 8 feet in length. The upper coal-bed of the section is stated to have been open formerly, and found 4 feet thick. From the low position of these beds, they must range through a wide extent of country. A shaft, sunk by us 2 miles W. of the above locality, brought to light a bed of coal, which is either the uppermost of the section or a still higher seam. The strata passed through will be seen from the following section:—

Olive Shale, 10 feet; Coal, 4 feet; Fire-clay, 2 feet; Decomposed ferruginous calcareous Sandstone, 3½ feet; Nodular Limestone in shale.

Throughout the country immediately N. of Philipsburg, a brown iron-ore is found loose in the fields; it is possibly derived from the ferruginous stratum mentioned in the section. The appearances at several localities are such as should induce a more thorough examination by the proprietors. One spot is on the turnpike, 3 miles N.W. of Philipsburg, and another 2 miles N. of the village. Examinations were once made at the latter place for hematitic ore, with the anticipation that it would prove like that of the limestone valleys E. of the mountain; but the operations were abandoned. A third locality is on Geerhart's Farm, near the Creek, 1½ miles S.W. of Philipsburg. Here loose pieces of limestone occur, associated with the ore. It is probable that all these exposures belong to the same part of the formation.

Coal occurs in abundance on the farm of John Goss, about 5 miles W.S.W. from Philipsburg, and 6 miles from the summit of the mountain. This is on the N.W. side of the Moshannon, 1½ miles S.E. of a high ridge, supposed to contain the first axis. The following section exhibits the geological position of the coal at this place:—

Coarse brown Sandstone; Black Slate; Coal too near the surface to be wrought, 7 feet; Interval, 20 feet, rock unknown; Coal, 2 feet; Interval, 15 feet; Coal, 6 feet 2 inches; Slate, 8 inches; Coal, 2 feet; Limestone, thickness unknown; Ore.—(See Fig. 363.)

The lowest coal-seam being separated into two beds, only the uppermost, which is 6 feet thick, is worked. It affords an excellent sound coal, free from sulphur and slate. This seam exhibits that tendency to a columnar structure which is so common a feature in the coal of all the basins immediately contiguous to the Alleghany Mountain. From its low position, in reference to the other strata, it ranges over a considerable extent of country. The uppermost coal-seam in the section occurs so near the top of the hill as to be too soft and dirty to work; from the same cause it does not spread over much extent of surface.

Coal occurs at two or three other places in this neighbourhood, showing a thickness of about 4 feet; but whether these localities belong all of them to one seam or to two, could not be ascertained.

From Philipsburg, S.W., the centre of the basin coincides very nearly with the general course of the Moshannon Creek, the strata on each side dipping gently towards the stream. The coal-beds along the S.E. side of

the basin have been developed in the dividing-ridge between Cold Stream and Trout Run, called "Coal Hill." The lowest bed at this place has its outcrop about a mile and a half N.W. of the summit. It was found to contain 5½ feet of coal, resting on more than 6 feet of excellent fire-clay. The fire-clay lies within 6 or 8 feet of the top of the Seral conglomeritic rock, the "Brown Rock" being here absent.

About 50 feet above this coal-bed occurs another, 9 feet thick, divided into two seams, by 10 inches of interposed slate, 2 feet from the bottom. The upper division, 6 feet thick, is alone worked. This coal is of sounder texture than most of that near the mountain, admitting of being mined in large square blocks. It is free from sulphuret of iron. This same bed has been opened 2 miles nearer to Philipsburg; it and the lowest seam have been estimated to occupy as much as 4 square miles of surface in the country between Trout Run and Cold Stream. The thick upper bed here mentioned lies at a level 250 feet below that of the summit of the mountain at "Emigh's Gap," which is about 4 miles distant. In Coal Hill we have indications in the benches on the surface, of at least three other coal-seams—the smuts of only two of which are penetrated; one proved to be 18 inches thick, and the other 4 inches; no attempt was made to open the uppermost. These benches, or indentations on the sides of the hills, when distinctly marked, are unerring indications of the presence of beds of coal. The dip is about 5° N.W.—(See Fig. 362.)

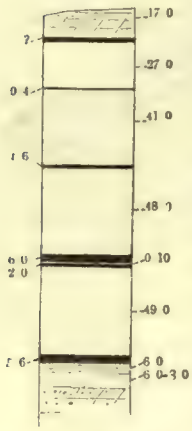


Fig. 362.—Coal Hill.

Examinations were made in this vicinity in search of the iron ore of the Umbral red shale, some old openings giving promise that the ore might here be found. The excavations, commenced by ourselves, were prosecuted with much spirit by Mr Philips. Ore has been found in several spots accompanying the white and red clay, or decomposed shale, immediately below the grits of Seral, but the coming on of winter prevented the proprietor from determining the thickness of the deposit and quality of the ore. A rather thick ferruginous bed does occur here, but no specimens have yet come to hand, enabling us to pronounce upon its value. Should this locality of the Umbral ore prove productive, the place would unite many advantages for the establishment of iron works, lying near the fertile valleys E. of the mountain, and possessing an abundant supply of coal, excellent fire-clay and sandstone, a sufficiency of limestone and excellent timber, both oak and pine, and an ample water-power on Cold Stream. The country here abounds in excellent white pine, which is always best towards the heads of the streams. Cold Stream now drives a large sawmill and a forge. During the winter months, coal in considerable amount is hauled by the route of Miller's Gap, into the valleys S.E. of the mountain, where it is sold at the rate of fifteen cents per bushel.

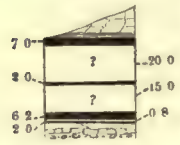


Fig. 363.—Goss's Coal.

On the Eastern Fork of the W. Branch of Muddy Run, on the county-line dividing Clearfield from Cambria, there occurs a large deposit of rich bog-ore, covering about 2 acres, and farther down the run, for a mile and a half, the springs in many places deposit the same ore in the form of a red ochre. This material is probably derived from the Umbral red shale, the surface on the Western flank of the mountain sloping rapidly to this point. A sandstone, corresponding in character to the Seral conglomerate, shows itself in the steep slope above the flats of the stream; it is probably between 30 and 35 feet thick. Four other benches appear higher up, the second of these, ascending, is watered by a spring, and the third and fourth exhibit signs of coal and fire-clay. It is said that springs depositing bog-ore occur in many places along the summit of the mountain, in a position answering to that of the Umbral ore, and in some places in sight of the furnaces and forges in the valleys below.

Mount Pleasant.—In this neighbourhood we meet with numerous indications of coal and limestone, though the inhabitants have rarely been at the trouble to develop either. Only one coal-bed, 2 feet thick, has hitherto been opened, though the benches in the hills, and the smut exposed in the fields, imply the existence of three other seams.

Along *Clearfield Creek,* near Blain's Run and Turner's Run, coal, fire-clay, and limestone are abundant, and judging from the evidences of iron ore, enough of this mineral may possibly be found to make this a valuable locality. A little up Blain's Run there is a bed of good coal, 5 feet thick, near the level of the stream, and under

it 14 feet of fire-clay, a part of which is well adapted for making stone-ware, and the rest fire-brick. A manufactory of the latter, owned by Mr Campbell, was established here, which yielded sometimes fifteen hundred bricks per day. Different varieties of good stone-ware have also been manufactured to some extent. Other seams of coal and indications of iron ore occur higher up in the same hill, above the coal already spoken of.

Farther down Clearfield Creek, a little above Porter's Run, there are three beds of coal, two of which are each 2 feet thick, the other 3 feet. There is also a bed of limestone 4 feet thick. Good kidney-ore, sometimes in one, sometimes in three bands, may be traced along the edge of the creek for several miles. The nodules are occasionally very large, but it is feared the quantity is insufficient to warrant mining. In this neighbourhood other beds of limestone were met with.

On the top of the hill near the Little Meeting-house, at Mount Pleasant, and occupying the highest position in the neighbourhood, is a thin bed of very impure limestone, of a brown and greenish colour, which breaks into square massive chunks. It is useless for any economical purposes.

Farther down, probably 80 feet, are slight indications of a coal-bed. It has not been explored.

Near the level of the run at Mount Pleasant is another bed of limestone, having above it a coal-seam, with fire-clay interposed. Above the whole is a bed of sandstone. The mineral characters lead us to suppose these beds to be Freeport Limestone and Upper Freeport Coal. If so, as the strata outcrop towards the Alleghany Mountain, another bed of limestone ought to be elevated in the trough ; but the thick soil and detritus from the limestone hills beyond cover up its outcrop.

The limestone bed seen on the Ebensburg Turnpike, 2 miles W. from the summit, is believed to be the same as that of Mount Pleasant. Its mineral character is precisely the same, and it is overlaid by sandstone, but the coal and fire-clay are absent. Some 40 or 60 feet lower down is a coal-seam of inconsiderable thickness.

CHAPTER VIII.

SECOND BASIN TRACED FROM THE SUSQUEHANNA S.W. INTO CAMBRIA COUNTY.

THE rocks upon the Susquehanna from the mouth of the Tangascootac, are almost horizontal, but an axis (No. 1) may be observed crossing the river within 3 or 4 miles above the mouth of Rattlesnake Run. Here the

FIG. 364.—Section along the Susquehanna West Branch at Rattlesnake Run, showing the Vespertine Cliffs.

upper members of the Ponent series form the base of the mountain, while the massive Vespertine grey sandstone stand out upon the precipitous sides, half-way up their slopes. For beauty and majesty the scenery is not surpassed by that of any other portion of the Union ; while the clearness with which its features are defined will afford the student of diluvial agencies the amplest scope for minute and varied observation. The entrance into the main valley of innumerable side-drains, down the channels of which currents of every variety of volume, force, and direction have swept, complicates the problem, and at the same time greatly heightens the interest excited in its solution. The conflict and reactions of currents have frequently given birth to eddy-formed hills of the most regular and interesting shapes, widespread plateaus, scooped hollows in the mountain-sides, and lines of perpendicular escarpment, not simply displaying fine exposures for the fossilist, but features worthy of accurate investigation by the natural philosopher. The section above (Fig. 364) represents some of these cliffs in the neighbourhood of the entrance of the Rattlesnake Run Valley ; the following (Fig. 365) shows a series of embouchures upon the same E. side of the valley, but higher up towards Young Woman's Town.

The grey Vespertine rocks, forming the cliffs shown in this Section, are about 50 feet thick, and everywhere

superposed upon a stratum of conglomerate from 5 to 10 feet thick: this is first remarked upon the river at a spot just below Farrandsville. Among the alternations below this conglomeritic layer, as they are seen upon the

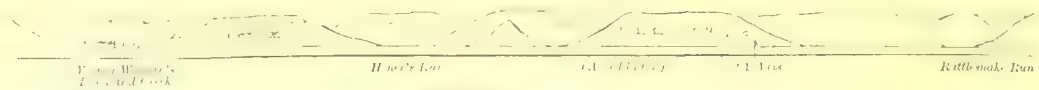


Fig. 365.

road after it has passed Rattlesnake Run, going Northward, may be observed whitish flaggy sandstone with a marked Vergent lithological type, tinted red where weathered. Below this massive stratum occur, Red sandstone, 20 feet; Red shales, 20 feet; Massive red sandstone, 10 feet; contorted irregularly-deposited grey sandstone, 20 feet. Red sandstones in regular series, and very massive, follow the above as the main body of the Ponent series, and descend below water-level.

Coal is not found anywhere between Tangascootac and Young Woman's Town; but a company, owning lands about the head of Hiner's Run, are said to have been engaged in opening seams identifiable with those of Lick and Queen's runs.

Blocks of the Seral conglomerate occur everywhere along the river, especially through "the narrows," or dry road along the mountain-side below Rattlesnake Run, and above Farrandsville. The pebbles are larger than a common pea.

Upon the surfaces of this rock, lying beside the road, where the State Engineer Corps were engaged in blasting out the bed of the Erie Extension Canal, may be observed abundant sections of a species of silico-ferruginous concretions, sometimes concentric, and of all sizes from a diameter of 5 inches downwards.

Immediately N. of the river, above the mouth of Young Woman's Creek, the basin is very shallow, only a thin remnant of the Coal-measures capping the very highest hills. W. of the mouth of Kettle Creek, coal was once opened 3 miles from the river up Cook's Run, where it was stated the coal was 4 feet 2 inches thick, divided in the middle by 2 inches of slate. At a somewhat lower position in the hill, between the Seral conglomerate and the "brown rock," a bench occurs which may denote another coal, though none is at present known to exist here. A bed, corresponding to that above mentioned, is said to have been once opened on the S. side of the river, opposite the mouth of Cook's Run.

A little S.E. of the last locality the land rises by the cropping-out of the lower formations that fold gently over the anticlinal axis separating the First and Second basins. At the mouth of the Sinnemahoning the red and grey flaggy rocks reach a height of fully 150 feet above the water, but only emerge above the river-flats at the mouth of Cook's Run. The hills around the head of Cook's Run are very high, but consist of formations which forbid the hope of finding coal. The Umbral iron-ore may perhaps underlie the conglomerate on the hills, though the probability is slender of its being of sufficient thickness to be profitable.

From a point several miles below Karthaus, the Coal-measures in the river-hills are quite productive, embracing several bands of iron ore, limestone, and some excellent coal-seams; and near Three Runs we have, besides, promising indications of the ore peculiar to the upper Umbral red shales.

The coal-basin deepening gradually as we ascend the river, the large upper bed at Karthaus does not enter the hills until we pass above the neighbourhood of Three Runs. At the latter locality occurs a bed of coal 3 feet 2 inches thick, which has been opened, associated with a layer of *limestone* and one of *fire-clay*. Openings were once made into a coal-bed and band of iron ore on the S. side of the river, at a point high up in the hills; but the success of the exploration is unknown. Tracing the coal-rocks back from the river for 2 or 3 miles in this direction, we find them gradually rising until they appear finally only in the highest knobs, beyond which they are succeeded by the coarse beds of the Seral conglomerate, expanded over the elevated tract designated "Highlands" on the State Map.

On Birch Island Run, which enters the Susquehanna below Karthaus near the county-line, and 30 miles N.E. of Clearfield, several beds of coal have been developed on the property of Dr Lorain. The most important of these is opened on the hill between the forks of the stream. The bed is said, by those who proved it,

to be 6 feet thick, and is regarded as the big Karthaus Bed. A still higher seam—4 feet thick—is found in the hill-tops, about 30 feet over the large bed. Iron ore is found associated with the shales enclosing it. Beneath the large coal—40 feet—a stratum of limestone 3 feet thick outcrops. On the same property farther W. two other coal-beds have been opened. They are reported as measuring 2½ and 4 feet respectively, and occupy a position lower in the series than the large seam.

At Karthaus the coarse sandstones and pebbly rocks of the upper part of the Seral conglomerate occupy the bed of the Susquehanna. The strata here dip about 5° towards the N.W., and preclude therefore any hope of finding the *iron ore* associated with the upper layers of the Umbral red shales. At Three Runs lower down the river the gentle rising of the strata may bring this part of the series into view, as already mentioned. The ore was here sought for just previous to the abandonment of the enterprise at Karthaus. A still more suitable spot will be on the S.E. side of the river, directly opposite the Karthaus Mines, on a small run divided from the river by two knolls. Here the conglomerate forms a perpendicular wall 25 feet high, the stratum dipping at an angle of 5°. The Umbral iron-ore should be searched for immediately at the base of this rock. Mr John James, the chief miner of the Karthaus Furnace, when it was in operation, compiled with considerable care a general section of the strata from the water-level to the summits of the hills near the furnace. This, with a few trivial additions to the column, is as follows :—

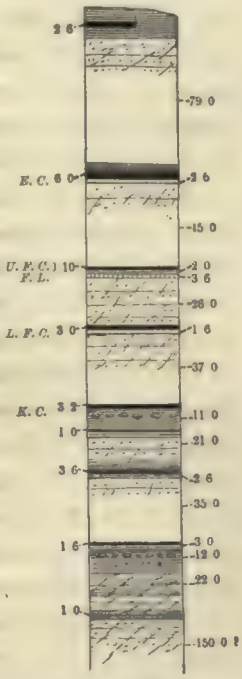


FIG. 366.—Karthaus.

Slaty Sandstone (up to the summit of the hill, 565 feet above the river) said to contain a coal-bed 2 feet thick, 79 feet. Black Slate, 1 foot. *Coal* (elevation, 479 feet), 6 feet ; fire-clay, poor, 2½ feet. Brown Sandstone, 45 feet. *Coal*, 10 inches ; fire-clay, 2 feet. *Limestone*, silicious, 3½ feet. Shale, 1 foot. Brown Sandstone, 26 feet. *Coal*, 3 feet. Slate, 1½ feet. Grey Sandstone, 37 feet. *Coal*, 3 feet 2 inches ; shale, containing 26 inches of good kidney-form iron-ore (elevation, 345 feet), 11 feet. *Coal*, 1 foot. Brown Sandstone and Slate, 21 feet. *Coal*, 1 foot ; slate, 3 inches. *Coal*, 2½ feet ; fire-clay, 2½ feet. Brown Sandstone, 35 feet. Coal, 1½ feet ; fire-clay, ferruginous, 3 feet ; shale, containing 25 inches of good iron-ore, called the "red ore band" (elevation, 268 feet), 11 feet 9 inches. Shale and slates, 22 feet. *Coal*, 1 foot. Sandstone, "the Brown Rock." *Coal*, thin. Seral Conglomerate, down to the river, 240 feet.—(See Fig. 366.)

There are in all 10 coal-seams of greater or less size in this part of the basin. The thick bed near the top is the only one hitherto mined. Lying near the summits of the hills, it does not, in the immediate vicinity of the furnace, occupy more than about 43 acres, though it enters a few small knobs to the N. and to the S.W., where the covering strata are thin. This bed is altogether 6 feet thick, but this includes 1 foot of inferior coal, near the top, which is not mined ; the remainder of the seam consists of very excellent coal, adapted to making a superior coke. Lower down in the measures occur two important beds of iron ore. One of these, at an elevation of 345 feet above the river, is estimated to contain in all 2 feet of good blue kidney-ore in 11 feet of shale. The other stratum lies at an elevation of 268 feet. It also exhibits about 2 feet of good kidney ore in a stratum of shale less than 12 feet thick. This band is locally called the "red ore," and is of a different variety from that above it ; they are both of excellent quality.

The limestone of this neighbourhood is for the most part inferior ; only one bed of it, 3½ feet thick, occurs in the series. Besides the thick upper coal there are three others of a size suitable for mining, one of which is 3½ feet thick, and the two others each 3 feet ; but none of these supply as pure a coal as the main seam.

Nine miles above this, on the river, the "red ore" has been found, and is stated to be thicker than at Karthaus. Three miles higher up there occurs a bed of coal near the summits of the highest hills, which measures 4 feet 4 inches in thickness ; this, there is some reason to suppose, is part of the main Karthaus seam. Between the two localities mentioned appears a bed of limestone. In this neighbourhood the Seral conglomerate and sandstone occupy a position near the flats of the river. The Coal-measures spread but a moderate distance from the river on either side, the underlying conglomerate rising out and capping the hills everywhere from 3 to 5 miles from the river.

Much difficulty was experienced in the district around the town of Clearfield in identifying the coal-seams of neighbouring localities, and after close investigation, aided by frequent diggings, the stratification remains quite obscure.

The largest and best coal-seam in this division of the basin is that on the property of Mr Thomas Reed, near the bridge over the Susquehanna, two miles from Curwinsville. It lies between 80 and 90 feet above the river, dipping at a considerable angle to the N.W. The coal-bed is here 3 feet 6 inches thick. We have been told that 100,000 bushels of this coal have descended the Susquehanna to Harrisburg. It forms an excellent fuel, as it contains but little sulphur. Like most of the coal-beds of the S.E. bituminous basins, it affects a species of columnar structure, being traversed by innumerable vertical fissures which render it somewhat friable. For its composition consult the chapter of analyses.

Near Curwinsville a coal-seam has been opened about 70 feet above the river, upon the hill-side, by William Irvin. The bed measures from 24 to 30 inches, but is not considered good. The same seam has been wrought by Isaac Bloom, a mile lower down the river. Here the coal is much better, and is only 20 feet above water-level. Between these two points, at Holden's, the same seam is 40 feet, and on Reed's land, 1½ miles from Curwinsville, it is but 12 feet above the river. These facts indicate a decided E. dip of the coal.

The next workable seam, the equivalent of Reed's Bed before mentioned, is perhaps 100 feet above the former. It has been opened both above and below Curwinsville on the higher river-hills. The nearest mine is that of P. Carns, one mile S.E. of the town. The seam at this point measures 3 feet 3 inches, including a band of slate, the usual companion of the bed, 2 inches thick and 9 inches from the bottom. Higher up the river it has been opened by Dr Hoyt, and by Mr Bloom, from whose mines large quantities were sent down the river in former years, and by others 4 or 5 miles higher up it. Underneath this coal is a bed of limestone 3 or 4 feet in thickness.

The following is a section of the coal strata in the vicinity of Curwinsville, compiled by estimation:—

Unknown strata in the highest hills, 100 feet; Coal, 3 feet 3 inches; Fire-clay, 2 feet 6 inches; Limestone, 3 to 4 feet; Shale, including two thin layers of coal, 25 + feet; Unknown strata, 75 feet; Lower Coal, 2 feet to 2 feet 6 inches; Sandstone, 50 + feet; Shale, 25 feet to river.

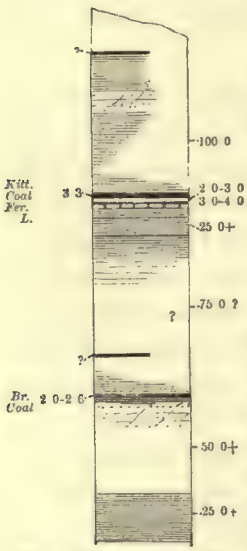


Fig. 367.—Curwinsville.

One and a half miles above Curwinsville, on the river, an old salt-boring is said to have penetrated a 6-feet bed of coal, at a depth of 100 feet. This stratum should be perhaps 80 or 90 feet below the river at the town.

High on Anderson's Creek Hill, about 2½ miles W. of Curwinsville, a coal crops out upon the turnpike. About 40 feet below this are indications of iron ore. A thick covering of debris prevents a close inspection of the strata upon this steeply-escarped hill-side.

On the N. side of the river, three-quarters of a mile above the town of Clearfield, occurs a stratum of fire-clay, of good quality, and 8 feet thick. Its position is a few feet above the river-bank. Oolitic iron-ore, seemingly of good quality, abounds in the upper part of the fire-clay, 2 feet of which contains about 1 foot of ore. A layer of similar oolitic ore, supposed to be the same, exists on Clearfield Creek, near the water-side, at the point of the Long Bend, amounting to nearly 2 feet of ore-balls in close contact. In the steep hill above this bed several seams of coal have been opened by Joseph Irwin, and the following strata are developed, as shown also in the accompanying vertical section (Fig. 367):—

Hill-top, 20 + feet; Coal smut, 0; (F.) Limestone, nodular, 0; Slaty sandstone and shale, 100 + feet; (L.F.) Coal, 18 inches; Fire-clay, 2 feet; Sandy shale, 25 feet; Compact obliquely-bedded Sandstone, 25 feet; Slate, 25 feet; (Kitt.) Coal, 8 inches; Slate, 5 feet; Limestone, 6 to 7 feet; Calcareous iron-ore, 2 feet; Sandy shale, 60 feet; Coal, 4 feet 6 inches, in two benches, the lower pyritous; Fire-clay, 4 feet; Slaty sandstone, 100 + feet; Coal, 1 foot 6 inches; Slate with ore nodules, 12 feet; Coal, 6 inches; Slate, 3 feet to river at low water.

The only coal-bed of the above series opened for mining is the large one beneath the thick limestone. The limestone is quite pure, and burns to a good lime.

At the town of Clearfield a seam of good coal is wrought to some extent on the land of Mr Moore. It lies between 40 and 50 feet above a stratum of sandstone that occupies the bed of the river, and measures 2 feet 10 inches in thickness. The outcrop of another shows itself near the top of the hill, a mile S. of the town; this seam has nowhere been accurately developed. On the hill-top, E. of the town, a coal measuring several feet, is said to have been opened years ago. Two small beds are found below Mr Moore's, but are unimportant. No limestone has yet been detected. Moore's coal-seam is conceived to be the same with Owen's Bed, 2 miles up Clearfield Creek, where the coal is 3 feet thick, and of excellent quality. Over it are the indications of three other seams. It has been mined in another place, 3 miles up the creek, where its thickness, however, only amounts to 20 inches. Though several other coal-beds occur here, this lower one is the thickest thus far discovered.

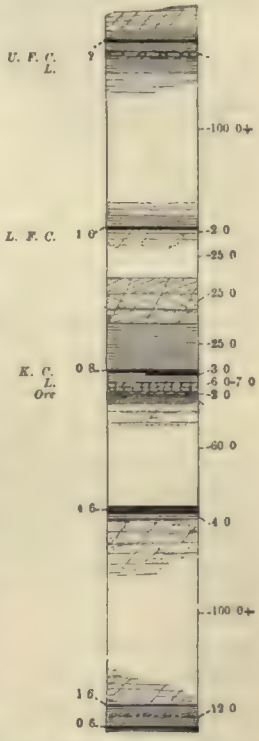


Fig. 368.—Clearfield Creek.

Besides the band of *iron ore* already noticed, several varieties of this mineral occur along Clearfield Creek. A rather peculiar, rough-looking ore, in large masses, some of them more than 100 pounds in weight, strew the surface of a tract of land lying a mile S. of the old turnpike. The mineral is heavy, but evidently not very rich in iron. A somewhat similar ore, possibly a part of the same bed, is to be seen on the E. side of the creek, at Beer's, where, though the surface-indications are encouraging, the quantity of the ore has not been proved. A peculiar compact shale or indurated slate-clay, of a bright blue colour, accompanies these ores, and is likewise found in association with another variety, 3 miles up Little Clearfield Creek. Here the shale, which is 12 feet thick, is less blue; scattered through it are small balls of ore. Beneath this is a considerable quantity of a coarse ore, in very elongated, somewhat cylindrical masses, like bars of pig-metal. It does not appear to be rich. On the old turnpike, near the tenth milestone W. of Philipsburg, appear two seams of good kidney-ore, requiring further digging in order to determine their value. On the new turnpike, near Roaring Run, a spring issues from immediately beneath loose masses of conglomerate, and deposits the red oxide of iron in a large bog. This spring forms a stream which propels Bloom's sawmill.

It is probable that we have here the line of contact of the Seral conglomerate with the Umbral red shales, and the presence of the usual band of ore at that place in the series.

Between Little Clearfield Creek and Mount Pleasant, the whole country consists of Coal-measures, none of the lower formations showing themselves in the position of the anticlinal axis, which elsewhere separates the First and Second basins. The chief feature, indicating the existence of an anticlinal axis between Philipsburg and Clearfield, is a high dividing-ridge, where, however, none of the lower rocks make their appearance. The obscurity in the outcrop of the strata along Little Clearfield Creek prevented our ascertaining clearly the stratification in that neighbourhood, to determine which would have required more time than we had at command.

This valley shows several good beds of limestone and some coal. At Mr Wright's, above Porter's Run, there are three coal-seams, two of which measure each 2 feet, and the other 3 feet thick. There is, besides a bed of limestone 4 feet thick, one, and in some places three, layers of good kidney-ore, lying in shale, which can be traced along the banks of the creek for several miles; the lumps are occasionally very large, but the whole quantity hardly sufficient to pay for mining. Going from Mount Pleasant towards Curwinsville, a limestone and an overlying coal vein, separated from each other by only a short interval, are seen in many places. It is supposed to be the Freeport Limestone, with its Upper Freeport Coal, and is undoubtedly the same bed with the one near the run at Mount Pleasant.

Near Curwinsville these strata occupy a higher level, being somewhat nearer to the second anticlinal axis.

According to the section made at Karthaus, the lower ferriferous limestone is wanting in that locality, as the bed of limestone noticed in that neighbourhood is estimated at 178 feet above the second great Coal-measure sandstone, which is precisely the position for the Freeport Limestone.

CHAPTER IX.

THIRD BASIN, FROM THE SINNEMAHONING SOUTHWARD INTO INDIANA COUNTY.

BETWEEN the Karthaus Hills of Coal-measures, in the Second Basin, and those of Bennett's Branch, in the Third, there passes a wide tract of elevated barren country, consisting of the coarse rocks of Seral conglomerate, which are here lifted to the surface by a broad and flat anticlinal axis. This axis of elevation, dividing the two coal-fields, crosses the E. Branch of Sinnemahoning a few miles above its mouth; then, curving gently Southward, it passes the main Sinnemahoning at the mouth of the Driftwood Branch, to range in a W.S.W. direction, through the high land dividing the waters of Clearfield Creek from those of Bennett's Branch. The belt of country immediately along this line presents few mineral features of importance. The Seral sandstone and Conglomerate cap the highest hills. Indications of iron ore occur in a few bog-ore springs, visible near the Sinnemahoning; but the great height and steepness of the hills, at the very summits of which it must lie, would render the ore, even if abundant, difficult of access.

The synclinal axis marking the middle of the Third Coal-basin crosses the E. Branch of the Sinnemahoning, about 10 miles above its mouth, and the Driftwood Branch at the same distance from its outlet, following the course of the stream. On the W. side of the Driftwood Branch one bed of coal has been discovered and opened near the level of the highest lands. A body of productive Coal-measures may possibly exist between this and Bennett's Branch, though, from the obvious shallowness of the basin here, the existence of such appears improbable. The country is excessively wild and rugged. The apparent extension of the Coal-measures for 5 or 6 miles N.W. of Bennett's Branch, up Hicks' Run and Trout Run, is a matter which claims some attention on the part of the proprietors of lands in this quarter.

At *Caledonia*, on Bennett's Branch, the basin becomes productive, the stratification embracing coal, iron ore, and limestone. This place is on the main stream, about 6 miles above the mouth of Trout Run. The hills on either side attain an elevation of about 550 feet, which they preserve for 3 or 4 miles back from the stream. On the S.E. margin of the basin, the rough rocks of the Seral conglomerate are visible on the Karthaus road, 4 miles S. of Bennett's Branch, dipping gently to the N.W.; and this dip continues to the N. side of the stream, the Vespertine strata, 2 miles above Trout Run, showing an inclination of nearly 5° in that direction. This N. dip, however, must soon change; for on Wolf Run, between 6 and 7 miles N.W. of Bennett's Branch, the coarse rocks of the Seral conglomerate again rise in the contrary direction, and cap the higher hills that bound the basin on the N.W.

Although the conglomerate at Caledonia (Warner's) lies but little above the flats which border the stream, yet 4 miles lower down the valley, in a N.E. direction, the subjacent Vespertine rocks appear at least 200 feet above the level of the water. This is due chiefly to the gradual ascent of the basin in that direction, and slightly to the fall of the stream; hence the probability of finding only a very limited amount of Coal-measure still further to the N.E., on Trout Run and Hicks' Run.

In the grey slaty Vespertine sandstones there occurs a bed of inferior sandy limestone about 4 feet thick. This contains many fossil shells and other marine remains, including those of one or two species of fishes. Associated with this limestone we find many little yellowish balls of excellent iron-ore. Between these and the Seral rocks we meet with indications of the bed of iron ore everywhere so prevalent in Umbral red shales, which formation itself seems to have thinned out. Up a little run, to be seen 1½ miles below Caledonia, we find a deposit of the soft bog-ore, derived, as usual, from springs flowing out of this part of the strata. We discovered

a fine natural exposure of the bed of hard ore about 1½ miles above Caledonia, on the edge of Bennett's Branch. At the latter place the current has cut away the loose rock and covering soil, leaving the ore in view under the overhanging Seral sandstone, the bottom of which is within 8 feet of the water. Immediately beneath the sandstone lies 1 foot of black shale, and under this 3 feet of brown shale, containing scattered nodules of the ore, underlaid by a solid bed of the ore, forming, with a very little shale, a bed between 3 and 4 feet thick. This overlies a band of fire-clay. The ore somewhat resembles that found at Astonville, and described in my fourth Annual Report. A recent slide of earth and loose rock, somewhat concealing the layer, prevented our ascertaining its thickness with perfect precision.—(See fig. 369.)

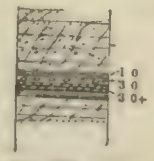


FIG. 369.—Caledonia.

The Seral conglomerate, the exact thickness of which was not satisfactorily determined, varies from a moderately coarse sandstone to a rough quartzose conglomerate in which the pebbles are occasionally larger than a turkey's egg. Large masses lie loosely scattered in great abundance: they present blocks of all sizes and every degree of relative fineness of texture, and admit of being easily split into fragments adapted to almost any building purpose. The whole stratum is probably about 100 feet thick, its lower edge, at Caledonia, occurring about 40 feet above the level of the stream. Above its top, the strata, which should contain coal, offer no exposures throughout a thickness of many feet. Near the head of a small stream, 4 miles below Caledonia, the upper edge of the sandstone is caught, lying about 300 feet above the flats; and very near this is a bed of compact yellowish shale, 4 feet thick, externally somewhat resembling a limestone. In no other place was this bed or any other visible near the top of the Seral conglomerate. The first stratum met with in the ascending order was a dark-blue shale, which occurs about 40 feet above the conglomerate. We had some reason to suppose that the interval contains a bed of coal. From the level of this shale upward, a tolerably minute section of the strata was procured by the aid of a pick and shovel, and the results contrasted with observations made in adjacent ravines and gorges. Some of the beds thus developed were found exposed on Warner's Run, and other thin layers were detected on Mead's Run, lying a mile to the E. From these various data the following somewhat detailed section of the rocks has been compiled. The more complete portion of the section terminates at the great bed of sandstone, 100 feet thick; but we have introduced several of the overlying beds in the order in which they were observed ascending the high lands N. of the sources of the above streams:—

White Sandstone, coarse, approaching a conglomerate, 50 feet. Coal, indicated by a bench, 0. Yellowish Sandstone, 40 feet (a bed of *Limestone* either above or below this stratum). Brown Shale, thickness unknown. *Coal*, 2½ feet (opened at Bockaway's on the turnpike); fire-clay, 6 inches. Sandstone, grey, slaty, with some interstratified shale, 100 feet. Black and dark shales, containing kidney-form iron-ore, 20 feet. *Coal*, 3 feet (upper 6 inches slaty); fire-clay, 1½ feet; fire-clay blue, good quality, upper part containing many iron nodules, 8 feet. Ore Stratum, with fire-clay (in all 3½ feet), comprising—Oolite iron-ore, 3 inches; blue clay, 12 inches; oolite ore, 6 inches; blue clay, 6 inches; oolite ore, 3 inches; blue clay, 12 inches, upon compact shale, blue and yellow, resembling externally a limestone, its upper part containing oolitic iron ore, 8 feet; olive shale, containing shelly ore, 8 feet; sandstone stratum, 1 foot; shale, with abundant ore, lower part massive and silicious, 45 feet; olive shale, 15 feet. *Coal*, 1½ feet; blue slaty sandstone, 5 feet. *Limestone*, 10 inches; clay, 12 inches; *Limestone*, 3 feet; fire-clay, 1 foot; dark shale (with ore in its lowermost 4 feet), 10 feet; olive shale, 2 feet. *Coal*, inferior quality, 1½ feet; black shale, 3 feet. *Coal*, good, 5 feet; black shale, 2 feet. Sandstone, 10 feet; black shale, 4 feet; sandstone and olive shale, with nodules of iron, 30 feet. *Limestone*, 4 feet; sandstone, 10 feet; blue shale, 6 feet.

FIG. 370.—Bennett's Branch Section.

In the accompanying Section (fig. 370) names are given to all the coal-beds, but these must not be implicitly accepted.

On several of the adjoining runs, the iron ore has been dislodged from its shale in great abundance, and the indications are such that we believe it might be profitably mined in several drifts

on the same stream. On the Clearfield Road, one mile from Caledonia, there is an exposure of iron ore on the road-side, but the exact place in the series occupied by this section has not yet been ascertained. It has been thought to be the same band as the "red ore" of Karthaus. Its position is not far above the upper edge of the Seral conglomerate. It consists of balls of heavy ore imbedded in shale, one-fourth of the lower 3½ feet of which consists of the ore. The excavation made to expose it evidently did not bring the whole of it to light.

The 5-feet bed of coal was discovered and opened by us where the above section was made, but we afterwards ascertained that it had been uncovered on other streams. This seam, consisting of sound coal without any slate, measures in one place 5 feet 2 inches in thickness. The lower limestone is blue, but it is not compact or close-grained. The upper limestone, probably the best of the two, is less blue, and of a finer texture. The blue and yellow compact shale, somewhat resembling a limestone, is a curious layer; it is often variegated, resembling occasionally a breccia, and is susceptible of a good polish.

Iron ore occurs abundantly in the shales above the second limestone; but in consequence of the difficulty we encountered in opening these beds and ascertaining the exact quantity of ore, we cannot venture to say more than that the indications are very promising. The quantity of the oolitic ore is considerable. The fire-clay on Mead's Run is a rather thick bed, and resembles precisely that worked at Farrandsville. The 3-feet bed of coal, containing in its upper part 6 inches of cannel coal, supplies a fuel much esteemed by the blacksmiths: besides occurring at this locality, it is found 4 miles N. of Bennett's Branch, at a spot one mile E. of the turnpike. In the upper part of the Coal-measures we met with one or more beds of fossiliferous limestone.

The facilities for mining the iron ore, coal, and limestone, in this neighbourhood, are certainly considerable; and these minerals all lie convenient to an ample water-power, which might be derived either from Bennett's Branch or Laurel Run, affording, if necessary, a fall of 50 feet, and water enough for extensive iron-works. The iron might be conveyed to market by the Susquehanna on rafts, the timber of which will pay, it is thought, all the expenses of the transportation. But these could only run during the spring, and occasionally in the summer, in times of freshet. During the winter, it is said, there is good sledding along the river on the ice. To reach a western market, it would be requisite to haul the metal about 20 miles upon a pretty good road to the Clarion River, whence it could be sent in rafts and arks from Ridgeway to Pittsburg. The neighbouring country is capable of maintaining ultimately a considerable population.

The basin of which we have here been treating extends to the S.W. up Bennett's Branch. It was found to be rich in coal and limestone for 10 or 12 miles above Caledonia. But the natural exposures of the strata near the sources of the streams are very few. The basin, both on the N.W. and S.E. sides, is bounded by high barren table-lands, in belts about 5 miles wide, capped by Seral conglomerate. The ridge of high lands on the N.W. is called Elk Mountain. A few of the knobs on the flanks of these broad ridges probably contain one or more of the lower coal-seams.

Coal-measures are found nearly 4 miles W. of Caledonia upon the flank of Elk Mountain, where it is crossed by the Ridgeway Turnpike. The lower strata outcrop, near the fork of the road leading from the turnpike to Winslow's, at the mouth of Trout Run. In the hills upon the latter stream, coal has been opened above Winslow's; and even as far as Spring Run, it is said to be found flanking the third axis.

The country above Luthersburg will be described at the close of the next chapter.

CHAPTER X.

THE FOURTH BASIN SOUTH-WESTWARD INTO JEFFERSON COUNTY.

The Third Axis, bounding this basin on the S., crosses the Driftwood about 7 miles below Portage (Emporium). Here it caps all the hills with Vespertine sandstones. But a little N. of it some remnants of Coal-measures encircle the heads of a few little streams, and contain one bed about 50 feet over the conglo-

merate, yielding 4 feet 9 inches of tolerable coal, with a seam of slate, 1½ inches thick, running through its middle. Its roof is blue slate, and a stratum of sandstone 30 feet thick caps the hill. No limestone is visible. Everywhere along the high edges of the hills (which are here, and N. above the Portage, between 500 and 700 feet high), under the bench of Seral conglomerate, —or white sandstone rather, for that is its character here—there issue springs depositing vast quantities of bog-ore. It being but 15 miles from Caledonia, where the Umbral red-shale ore is so thick and abundant, the reasonable supposition is, that up the Driftwood, in this neighbourhood, the ore might be obtained in large quantities.

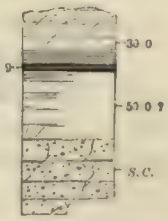


Fig. 371.—At Emporium, 3d Basin.

North of this, as far as Portage, the hills are capped by Seral conglomerate. Three miles above Portage, West Creek enters the Driftwood from the W. In its valley ranges the N. boundary of the basin, axis No. 4, which brings up about 20 feet of Vergent rocks above the water-level, while the rest of the hill-side is made up of Ponent, but principally of Vespertine rocks. The Ponent formation is here rapidly thinning toward the N.W. across the basins.

The S. dips are everywhere about 5° N. of the S. axis; a Vergent stratum exhibits a dip of 6° to the N.N.W.

The Vespertine sandstones are about 400 (?) feet thick upon the Driftwood at the third axis.

Five miles N.W. of Bennett's Branch, ranges the summit of the high ridge designated on the map of the State as the Elk Mountain. Its elevation above the stream is not far short of 600 feet. The sandstone and conglomerate rocks, constituting the Seral conglomerate, here reach the surface, and form a rough and stony belt nearly 4 miles wide. The rise of the strata on the N.W. side of the Bennett's Branch Basin is tolerably rapid. About half-way across the broad anticlinal elevation of Boon's or Elk Mountain there occurs a considerable exposure of red soil, derived either from the Umbral red-shale and iron-ore stratum, or from the upper layers of the conglomerate—which latter formation, however, it can hardly be.

The fourth axis, which separates the Fourth and Fifth basins, after indicating its presence, as we have shown, upon West Creek, by elevating strata beneath the Coal-measures, leaves the valley of that stream, and ranges S.W. At Roselay the Seral conglomerate strews the surface over a broad expanse. The precise line of the axis is not easily defined in the wild country through which it passes to the S. of St Mary's, but it again appears upon the Centreville (Kersey) and St Mary's Road, at the crossing of Laurel Run. In this neighbourhood the Seral conglomerate occupies a place low in the hills upon the water-courses, and the Coal-measures are cut out over a comparatively narrow belt. We find the conglomerate cropping on the Centreville and Ridgeway Turnpike at the forking of the Brandy Camp or Brookville Road. On the latter road, nearly a mile S. of the turnpike, it may be seen dipping 10° S.E. into the Fourth Basin, or that of Little Toby Creek. To the W. of this line, towards Ridgeway, the surface is sheeted by that formation, which gently undulates into the Fifth Basin. There is, therefore, but little hope of finding valuable coal-strata, except on the higher grounds, where the conglomerate has disappeared S.W. of the fork of the Brandy Camp Road. But a small part of the Seral conglomerate stratum, along the line which we have been tracing, is pebbly, the chief portion being a coarse yellowish sandstone, marked with ferruginous streaks. At the upper edge of the stratum is a layer of compact white silicious sandstone. This bed, when it disintegrates, forms a remarkably pure white sand, which in some places is found in great abundance.

The centre of the Fourth Basin coincides with the general course of the Little Toby Creek (unnamed on the map) S.W. into Jefferson County. On the N.W. we have already traced the boundary of the Coal-measures; on the S.E. they extend high on the flank of Boon's or Elk Mountain.

Several sections of the strata in different parts of the basin were obtained, some of them embracing an almost complete series of the rocks and included minerals. In these researches we ascertained the existence and position of two valuable beds of limestone, which we believe to be continuous over a considerable area of country, together with several impure bands found to be destitute of fossils, and the continuity of which we consider doubtful. The sections are compiled from observations, made in one case on the E. side of Brandy Camp Creek (Kersey Creek of the map), about 5 miles S. of the turnpike; in another instance at a point nearly oppo-

site, on the W. side of the same stream; and in a third at Kyler's, situated near the head of Little Toby Creek. Some of the results included in the sections were procured near the head of Brandy Camp Creek, at Mr Thompson's; and on Limestone Run, which enters Little Toby 4 miles below Jesse Kyler's.

On the road between Centreville and St Mary's, about 2 miles from the former place, along the bank of a small stream, tributary to Elk Creek, there is a deposit of bog-ore of several feet depth. On the hill-sides near by, a thin bed of slaty cannel-coal occurs: it has not been opened. On the hill-top N. of this, an impure variety of limestone strews the surface.

A large deposit of red bog-ore occurs on the land of Mr Thompson, near the head of Brandy Camp, adjacent to the conglomerate, and seems to be connected with filtration through the body either of this rock or of one of the ferruginous sandstones above it. Though no satisfactory exposures of Seral conglomerate were here seen near the level of the ore, the stratum was detected in the bed of the stream, at a somewhat lower level, 1 mile lower down the Brandy Camp, and 20 rods beyond was seen a bed of *limestone* in the edge of the creek, and over it about 40 feet of dark-coloured shale. This shale, in other localities, was discovered to abound in kidney ore, and the deposit in question might by some be referred to it, but I more incline to attribute it to the sources above adverted to. It covers in all an extent of perhaps 10 acres, and was proved to be in one place 7 feet deep, though its average depth is believed to be not so much.

The upper edge of the conglomerate seems here to be below the level of the stream; but 25 feet higher up are beds of shale, containing large masses of rather coarse nodular iron-ore, and at an elevation of about 75 feet there is a seam of coal, from 3 to 4 feet thick, the upper part of which is cannel coal. About 25 feet still higher in the series lies a bed of limestone, characterised by small univalve fossil-shells. Indications of a still higher seam of coal occur in the channel of the run above this limestone. Directly under the coal below the limestone is a layer of excellent fire-clay. The position of these beds in the series will be readily seen from the section to be presently given.

The lower limestone near the conglomerate was met with again between 5 and 6 miles to the S.S.E. on Limestone Run, which enters Little Toby about that distance S. of the turnpike, and heads 3 miles still farther S. The rock here is of a lighter colour, but it contains the same fossil shells and encrinites. This bed was found by one of our party 6 feet thick on an adjacent run, accompanied by a trace of coal directly beneath it, supported by a layer of fire-clay containing balls of iron ore. This is about its thickness on Limestone Run, where almost immediately below it lies the upper edge of a band of sandstone, just visible, with many imbedded impressions of fossil plants. This stratum was supposed to lie not far above the conglomerate. About 15 feet over the limestone is a shale abounding in iron ore, the lumps of which are numerous in the channel of the Run. It is of various qualities, but promises well as far as quantity is concerned.

Signs of coal occur here, evidently dislodged from some higher level, though the outcrop of but one bed has been opened and mined. Coal was obtained from it for lime-burning by Dr Earley and Mr Kyler. The hill ought to contain, we conceive, at least three seams of coal; but its position, it should be observed, is on the S. margin of the Coal-measures. The soil of the adjacent country is decidedly good, and we have shown that the region is far from being deficient in mineral treasures. The day must come, therefore, when it will sustain a considerable population. The hills are by no means high, rarely more than 300 feet. Pine timber is abundant, and our commoner hardwood trees attain a very large size. The settlers are still thinly scattered.

In collecting the results of the following sections, our practice was to open the outcrop of all the more important beds sufficiently to ascertain their exact thickness by measurement. While obtaining materials for this description, we were much assisted by Mr Jesse Kyler, from whom we derived much valuable information.

The comparison of the sections in column does not settle the identification of the various beds. The best guide hereafter will be the limestone with univalve fossils.

Column (fig. 374) near Parkhurst's (Horton's), E. side of Brandy Camp Creek:—

Olive shale; Coal, slaty, 2½ feet; Blue sandstone, 20 feet; Black slate, 2 feet; Coal, good, 2 feet 8 inches; Grey sandstone, 15 to 20 feet; Bluish-grey sandstone, 10 feet. Interval, supposed to contain a limestone; Olive shales, more

than 5 feet; Dark sandstone, 7 feet; Coal, slaty, 1 foot; Black slate, 1 foot; Bluish shale, containing ore, 8 feet; Grey sandstone, more than 20 feet; Interval of a few feet, supposed to contain a limestone; Coal, good, 2½ feet; Fire-clay, 6 inches; Blue shale, abounding in kidney ore; Interval, 30 feet; Sandstone, 2 feet.

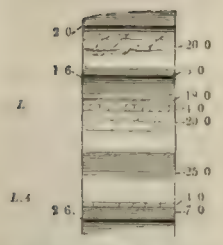


Fig. 372.—Brandy Camp (opposite Horton's).

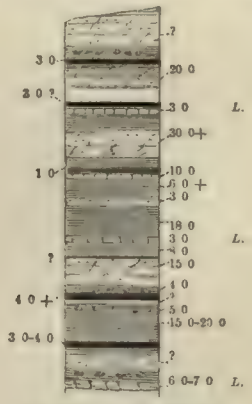


Fig. 373.—Little Toby Creek (Kyler's Coals).

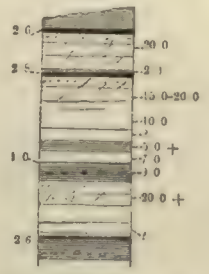


Fig. 374.—Brandy Camp, (Horton's.)

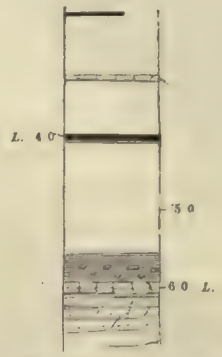


Fig. 375.—Limestone Run.

The abundance of iron ore in the bluish shale near the bottom of the section, and a comparison of the several beds with those found on Limestone Run already described, lead to the inference that the interval of 30 feet immediately below must contain the lower limestone of the section following.

Section of the strata in the hill on the W. side of Brandy Camp Creek (Fig. 372), opposite Parkhurst's Horton's):—

Olive Shale. *Coal*, good, 2 feet; Fire-clay. Sandstone, 20 feet; Olive Shale, 6 feet. *Coal*, cannel, 1½ feet; Black Slate, 12 feet. Sandy Shale, 2 feet; Black Slate, 1 foot; Sandy Clay, 3 feet. *Limestone*, blue compact, 4 feet; Sandy Olive Shale, 20 feet. Black Shale, 2 feet (Coal probably thinned out); Blue Shale, 25 feet. *Limestone*, blue compact, 4 feet; Olive Shale, 5 feet; Black Slate, 2 feet. Coal, 2½ feet (lowest bed exposed upon the Creek).

Section of the strata at Kyler's, 1 mile S. of the turnpike, head of Little Toby Creek—(Fig. 373):—

Coarse Sandstone; Shale, containing ore. *Coal*, good, 3 feet; Sandy Shale, 20 feet. *Coal*, slaty, 3 feet. *Limestone*, 3 feet; Shale and Sandstone, 30 + feet. *Coal*, about 1 foot; Impure Limestone and Shale, 10 feet; Olive Shale, 6 + feet; Conglomeritic Sandstone, dark-coloured and somewhat calcareous, 3 feet; Blue sandy Shale, 18 feet; Impure Limestone, compact, 3 feet; Olive Shale, upper part, a compact whetstone, 8 feet. *Coal*, slaty, thin; Sandstone, thin-bedded blue and grey, 15 feet; Blue Shale, with nodules of sulphuret of iron, 4 feet. *Coal*, 4 + feet; Slate, &c. (?) feet; Brown Shale, containing iron ore, 5 feet; Black Slate, from 15 to 20 feet. *Coal*, of good quality, 3 to 4 feet; Fire-clay, sandy; Sandstone and shale, with kidney ore, 50 (?) feet. *Limestone*, 6 feet.

The two lower coal-beds of the above section have been opened at various points in the vicinity of Centreville (Kersey). The lowest has been mined by Dr Earley, by Mr Macready, and by Mr Howe. The mine of Mr Jacob Taylor, a mile S. of Centreville, is probably upon the same bed. Here the coal is said to exceed 6 feet in thickness, but could not be examined by us, the earth having fallen over the opening. At the village of Centreville, a coal is opened at water-level, measuring 3 feet 6 inches. Fifty or 60 feet higher in the series a coal 1 foot thick is found, and above it are indications of a slaty cannel-bed. The second bed ascending is opened by Mr Kyler and Mr Whaland on Little Toby Creek, and by Mr Keller: it is probably the same as the larger seam at Centreville.

We conceive the limestone at the base of the above vertical section to be identical with that found in the neighbourhood of St Mary's, where it overlies several beds of coal, as we shall hereafter show.

The lowest of the blue limestones of the section opposite Horton's being discovered nowhere else, and being somewhat sandy, we have supposed it might disappear by degenerating into a calcareous sandstone. The coal-seams vary considerably in thickness and quality, showing a transition from glance to slaty cannel-coal or bituminous slates. The second coal ascending, recorded in the sections at Horton's and at Kyler's, appears to have thinned away in the locality opposite Horton's. It may possibly have escaped notice in the stratum

marked black shale, as slaty cannel-coal, of which it consists at Horton's, much resembles at its outcrop a black coal-slate. These coal-seams have been worked to a limited extent for consumption in the neighbourhood. The shales and sandstones, it will be observed, graduate into each other without regularity. The first bed of limestone ascending in the series, contains a small univalve shell, apparently a goniatite, which, being easily distinguishable from the fossils of the upper and lower limestones, may serve as a feature by which to recognise the stratum. No bed of iron ore was discovered so promising as that in the lower bed of shale, though less abundant exhibitions of ore are not unfrequent in other members of the series.

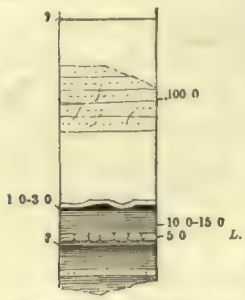


FIG. 376.—Hemlock Run.

The neighbourhood where the foregoing sections were obtained is about 8 miles from the Clarion River. The country around possesses a pretty good soil, and the surface is such as to admit of the construction of good roads.

Approaching the Brookville Turnpike, a section, represented in Fig. 376, was obtained upon the Little Hemlock Run, near where it is crossed by the Brookville and Toby Creek road, 9 miles E.N.E. of the former. The Third Axis is supposed to pass close by it upon the E. This fact, while it properly throws the section into the next basin, also serves to identify its limestone with one of the lower beds in the series. It dips N.W. 80°. Beneath it is a coal-smut, supported by 5 feet of black and blue shales, then sandstone.

Over the upper much-crushed coal-bed is a bed of fire-clay, which indicates the presence elsewhere of an upper member.

The sides of the ravine in which the little creek flows, seem to be composed wholly of hard sandstone, perhaps 100 feet thick, and then upon the face of the country around the coal-bed presents its outcrop in a terrace, as yet nowhere mined.

At the *Brookville and Curwinsville Turnpike* the Fourth Basin is of sufficient depth to retain a great depth of olive shales and black and variegated slates, which are exposed along the turnpike between Goodlander's Tavern and the opening upon a large coal at Fuller's Old Bank, 2 miles E. of Reynoldsville. On the W. side of the basin Coal-measures are found until we pass W. of Baum's Tavern, upon the turnpike crossing the high lands. Opposite the tavern a coal-bed 4 feet thick has been opened above a bed of limestone. Half a mile W. of Woodward Reynolds' a bed of coal has been exposed in the cuttings of the road; over it are many feet of green and grey shales, and under it a mass of slates and shales, and then a massive sandstone. Its terraced outcrop is well marked on the hill. A spring issues from it.

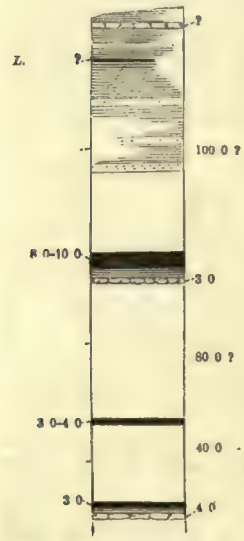


FIG. 377.—Reynoldsville, S. Branch of Sandy Lick Creek.

The accompanying column (Fig. 377) was constructed from data obtained in the vicinity of Reynoldsville and Woodward Reynolds' Tavern at the South Branch of Sandy Lick Creek.

The limestone indicated at the base of the Section appears in the bed of the South Branch, about a quarter of a mile below the Turnpike Bridge, and is partly carbonate of lime and partly carbonate of iron, coarse and blue. It seems to be 4 feet thick, and may be more. How much above it the coal-bed may lie which was formerly mined from the bed of the stream half a mile higher up, does not appear, but the distance cannot much exceed 10 feet. This coal-bed yields 3 feet of excellent coal where the running water has least eroded it. Both coal and limestone are almost perfectly horizontal, and no exposures occur in the precipitous hill-sides of the creek between the two strata. The same two beds, similarly ambiguous in relative position, and thus evincing close proximity, are to be seen upon a little run some miles E. of this locality, near Mr Standring's farmhouse. At this point one or two higher small coal-beds are found. Forty or fifty feet still higher in the series is a bed of coal, formerly wrought below the turnpike W. of Reynoldsville, and in the field back of Woodward Reynolds' house. It is said by those who opened it to be fully 3 feet thick. The next important stratum ascending is a large bed of coal. This seam, which is important because of both its size and purity, is wrought at various points in the

vicinity of Reynoldsville. The nearest mine is that of Thomas Reynolds, where the bed measures 7 feet 8 inches from top to bottom. The upper 12 inches are rather soft. Two thin layers of slate divide the bed, one 2 feet from the top, the other 18 inches from the bottom. Only 5 feet of the coal are mined for use. S. of the town the bed is opened by Woodward Reynolds, J. Sheesley, Ludwick, and others. At Woodward Reynolds' it attains a thickness of from 10 to 11 feet, though the upper 4 feet are somewhat slaty. The remainder is mined. The coal is hard, lustrous, and remarkably pure; it finds a ready market throughout the surrounding country. It is important to remark that beneath the large coal at Woodward Reynolds' bank, and at Thomas Reynolds' old bank near the village, a stratum of limestone is met with; though in some places 3 feet thick, it is not always found. Woodward Reynolds used it to supply lime for building purposes.

At Reynoldsville the outcrop of the coal may be seen, 125 feet above the creek, circling round the hill. No higher coal-bed is seen above it there, though the more elevated points contain a small seam many feet over it. The large bed is betrayed by its smut, on the turnpike E. of Cather's Mill, on the land of Mr Fuller, by whom it has been mined. The small bed appears on the high ground above. On land formerly owned by Tilton Reynolds, now in possession of his heirs, the Big Coal is opened on the hill-side below the turnpike; at this point it is much higher than at Reynoldsville, and seems to be approaching its E. outcrop. No coal of like dimensions has been opened E. of this towards Luthersburg, and the question whether, after crossing the third axis, it enters high ground again, or whether it reappears under reduced dimensions, is not susceptible of solution until the several beds of coal and limestone are systematically proved and compared. The question of most preliminary importance touches the relationship which the limestones at Reynoldsville bear to that which we shall presently notice as found at Luthersburg. Much hesitation is felt in giving names to the several beds, but if we accept the most probable view, we shall regard the large coal as an unusual development of the Lower Freeport Coal—which, we know, fluctuates more than almost any other—and the limestone beneath as a purely local deposit. In this case the lower limestone will represent the ferriferous stratum.

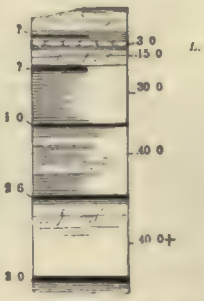


Fig. 378.—Luthersburg.

Passing into the Third Basin, we find in the neighbourhood of *Luthersburg* the strata exhibited in the section (fig. 378). The principal openings are those of Irvin and A. Pentz. The former has developed two beds in the woods N.E. of the town. The upper measures 2 feet 6 inches, the lower from 2 feet 6 inches to 3 feet. The lower coal is mined by Pentz, near the Clearfield Turnpike, three-fourths of a mile E. of the town, where it is 2 feet 8 inches thick. Forty or fifty feet above it, on the turnpike, indications of the upper bed are seen resting on fire-clay. The same bed was penetrated by Mr Hover's well on the hill-side at Luthersburg; it was encountered 9 feet below the surface, and proved to be 2 feet 6 inches thick.

A coal-bed 1 foot thick was cut through by several wells on the higher ground at Luthersburg, at Long's, or Wilson's, &c.: it ranges through the town at the level of the roadway at Moore's Tavern. The existence of a fourth bed appears to be indicated by springs and black dirt on the hill just E. of the town. It has never been opened, but cannot be thick. Above this locality, on the Curwinsville Turnpike, limestone has been quarried to a small amount by Mr Irvin; it occupies only the high ground. It is grey, compact, sonorous, and, when weathered, yellowish or brownish, from the amount of iron which it sometimes contains. It was seen non-ferruginous at a place one and a half miles S. of the Turnpike at Luthersburg. Above the limestone is the black part of a coal-bed. The summit of the hill at the Curwinsville Turnpike, E. of Luthersburg, is a coarse micaceous sandstone, displaying impressions of Calamites. A coal-bed crops out on the road about a mile and a half E. of the town; it is probably the second coal, ascending, of the section. At Seyler's Foundry, one mile and a half N.W. of the village, a coal-seam corresponding to the lower bed is wrought; it is 4 feet thick. At Reisinger's, 4 miles N.E., limestone is taken from the hill-tops, and burnt for lime.

CHAPTER XI.

FIFTH AND SIXTH BASINS IN POTTER, McKEAN, ELK, AND FOREST COUNTIES.

THE lowest coal-bed is wrought at a spot 2 miles N. of the Smethport Road, 4 miles W. of Coudersport. It is opened on ground 40 or 50 feet lower than the highest surface of the hill. A shaft was sunk in grey sandstone to a depth of 30 feet to reach the coal of the drift, but it was not deep enough. At the outcrop the bed measured from 16 to 20 inches in thickness, and a drift was carried in upon it 200 or 300 yards. In the drift the coal expanded to a thickness of 3 feet 7 inches, and at the end of the workings it measured 3 feet 11 inches. It is subdivided by 2 inches of slate. The lower bench is a little slaty. The coal is pronounced very good by blacksmiths. The same bed makes its appearance upon the Olean Turnpike about 6 miles from Coudersport, and probably in the deepest part of the Fifth Basin. Blocks of conglomerate lie in confusion upon the surface of a steep slope 50 feet in height, above which are two regular terraces, each at least 60 feet in height. Here the coal may be opened.

The conglomerate can be traced along the sides of the valleys, and may be seen forming cliffs upon a hill-side within a mile of Coudersport, at the foot of which runs the Olean Road. Along the road are unequivocal upper Vergent green sandstones intermixed with red shales, which are doubtless to be referred to the Mansfield ore-stratum (described in treating of the valley of Wellsborough). Upon the red soil rest large blocks of conglomerate, slipped down from the cliffs above. The whole Seral-sandstone system must be here at least 100 feet in thickness. The base of the cliff rests upon concealed Vespertine grey sandstones, but the Ponent rocks are absent.

A small area of coal, perhaps overspread by the Seral conglomerate, is found in the centre of Sweden Township, S.W. of Stockholm. Iron Pyrites is abundant in the neighbourhood.

Coal is found to the Eastward in Pike Township, on Pine Creek, but it cannot belong to the true Seral Coal-measures.

In the extreme N.E. corner of Potter County, in Harrison Township, a variety of limestone has been found, and used for plastering; it is very impure. Passing along the road leading from Coudersport N. to Wellsville, alternations of red shale with olive and grey shale are quite conspicuous on the hill next N. of Glassmyres, to a thickness of perhaps 70 feet. Ascending the hill 1½ or 2 miles from Glassmyres, loose red matter is visible, succeeded by blocks of coarse thick-bedded rock; but after passing the summit, about 4 miles distant, the soil is again tinged deep red. Descending the long hill to Election Schoolhouse, a similar thick grey sandstone to that seen above is strewn in fragments on the surface. In the depression at the Schoolhouse the soil is red, but on the ascent N. of it its aspect changes, and a grey sandstone is strewn over the surface. On the top of the hill, 2 miles from Ellisburg, the soil is red and slightly gravelly; but a little beyond this point, brown, purplish, and green sandstones appear, and on the bank of the stream below, an exposure of some 20 feet thickness of mottled greenish sandy shales and shaly sandstones appears, having all the aspect of Ponent rocks. The whole thickness indicated above the quarry, where more of the greenish shale is ploughed up, must be at least 40 feet, and it is perhaps much more.

The same rocks are evidently exposed on the road in flags about half a mile S. of Ellisburg. If this is the case, the Ponent strata, to which these are referable, must be from 80 to 100 feet in thickness.

Northward of Ellisburg, occasional exposures of undoubted red shale soil and green flaggy rock appear; this occurs along the level as much as 50 or 80 feet above the stream, and again shows itself, mingled with green flaggy rock, on the high ground near the hill-tops, 2 miles from the State line. The exposures continue half a mile or more, after which green flaggy sandstone appears on the point of the hill, descending toward the State line. Between this point and Beansville, 1½ miles N. of the line, there are no exposures, though red shale is said to exist on the hill-top, half a mile S. of the latter place. At Beansville there are many blocks of white argillaceous sandstone, containing impressions of Scolithus, Encrini, &c., in the loose material.

The following strata are exposed in a descending order, in a hill 3 miles S. of Wellsville, New York—(See Fig. 379):—

Grey and brownish thick-bedded sandstone, 30 feet; Grey flaggy and brownish sandstone, 20 feet; Brownish

sandstone with Cypricardia, 10 (?) feet; Grey flaggy sandstone, 20 feet; Red shale, 10 (?) feet; Green micaceous flaggy sandstone, 25 feet; Green micaceous flaggy sandstone, more thickly bedded, 25 feet; Green micaceous flaggy sandstone, brown, with coarse pebbly layers, 20 feet; Flaggy sandstone, and green and greenish shales, 20 feet; Strata concealed by blocks of grey sandstone, &c., with Cypricardia and other fossils, 50 feet.

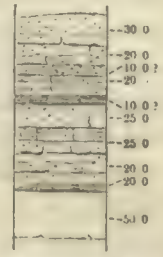


FIG. 379.—Cliff Hill, 3 miles S. of Wellsville, New York.—1 *inch* = 200 *feet*.

The very top of the hill in which the preceding section was made is occupied by grey and brownish rather argillaceous thick-bedded sandstones, some layers containing small pebbles. Below this are the flaggy rocks, underlaid by brown argillaceous beds, containing a profusion of Inoceramus, &c. This is a good locality for casts of these fossils. The shales appeared to have a thickness of about 10 feet. Beneath these occurs a grey flaggy sandstone, and then the earth is full of red shale, abundant and pure, just above the top of the ledge which forms the cliff, as seen from the road. Although this rock was not seen actually bedded, there can be little doubt that it occupies the position indicated beneath the fossiliferous layer.

The rock next below is the peculiar thin-bedded, platy, micaceous green sandstone, occurring so usually as an alternation with the red shale of the Ponent series; it is destitute of fossils. This graduates below into a more thickly-bedded but still flaggy rock of a soft, tough, rather conglomeritic texture, weathering to a peculiar buff-grey, such as has been noted in the vicinity of the red shale at points further S.

Below this is a similar rock, more brown when weathered, and brownish red within; in this are numerous pebbly layers, and fossil impressions are sparsely scattered throughout the mass. It passes below into a more thin flaggy and greenish sandstone, and green argillaceous shales.

The rest of the slope is concealed by the debris of the above sandstones, in which fossils are now and then seen.

As this hill is higher than those about Wellsville, it would seem that they are capped by the same rocks.

The Sixth Basin enters the State of New York, along the N. border of Potter County, and certainly contains no coal where it is traversed by the Coudersport and Olean Turnpike. Fragments of the Seral conglomerate are seen in great abundance in the neighbourhood of Ceres, upon the Oswaya Creek. Still farther N. we have yet lower strata: thus, in a quarry half a mile S. of Olean, we find well exposed a thickness of 20 feet of the Chemung or Vergent rocks, a few thin layers of which are very fossiliferous. Some of the partings between the sandstone flags consist of red shale, though the greater number of these are olive slate.

The quarry is at an elevation of at least 100 feet above the Alleghany River.

About 2½ miles S. from Olean, the hills embrace the following strata:—

1. Vergent Rocks of the usual Chemung type, at an elevation above the Alleghany River, at Olean, of about 350 feet.

2. Ponent Red Shale, visible on the side of a road leading up the hill from a steam sawmill, at an elevation above the river of 400 feet. Below this point at which the red shale seems to be in place, the ground is stained more or less distinctly for 50 feet with the red matter of the Ponent rocks, and displays red-shale fragments; but whether this series is in place for this thickness, is questionable.

3. Immediately above the red shale, at the Spring, appear beds of Vespertine grey sandstone, more or less replete with two organic forms. This group extends to the summits of the highest hills here, at an elevation above the Ponent of perhaps 100 feet. This Vespertine series consists of the evenly-bedded greenish-grey sandstone layers, weathering greyish white; they are from 1 to 12 inches thick, separated by partings of olive shale, which itself occurs in beds of some thickness. About half-way up in the mass, or 50 feet above the red shale, a quarry shows the sandstone in solid bands of from 6 to 12 inches in thickness. The uppermost layers on the summit of the hill are thin, and some of them contain small oval flakes, and pebbles of olive shale, seemingly derived from the Vergent rocks; also some vegetable remains, apparently stems of ferns. The other two organic forms spoken of as occurring in the rock are the bifurcating perpendicular stem-like fossil, seen in the hills near Warren, and the species of Scolithus likewise found in the same neighbourhood. These two transversely-disposed fossils appear to prevail most in the lower half of the first 50 feet of the mass.

The hill-tops throughout the N.E. extension of the Sixth Basin display huge scattered blocks of the Seral conglomerate, some of them of the size of a moderately-large dwelling-house. None of this conglomerate shows itself in place here; but from the magnitude of the blocks, it is plain that the original stratum lay very nearly at the level, and in the places occupied by these masses. It is said that the rock is not actually in place nearer than 5 or 6 miles S. from Olean. In lithological character, too, the conglomerate is somewhat peculiar, the pebbles being long and flat, and arranged very regularly several inches asunder, and generally parallel.

A well-defined N. and S. valley of denudation (one of the series of channels along the Northern tier of Pennsylvania, from Susquehanna County westward), is that along which, in opposite directions, flow the Drift-wood Branch of the Sinnemahoning Creek, and that stream which unites the Alleghany River at Conoe Place, or Port Alleghany.

A similar long straight valley, parallel with the former, contains the waters of North and Potato creeks. Along these our chief observations were made.

Throughout nearly their whole extent, the Vergent and Ponent rocks occupy the bed of the valley, the high lands on each side being capped at the fourth axis by the Vespertine, at the edges of the fifth basin by Seral conglomerate (as also at the arch of the fifth axis), and by lower Coal-measures in the centre of the Fifth and Sixth basins.

Now almost all the bottom-washes of these valleys are full of an adulterated bog-ore, apparently the result of ferriferous water from the red bands of shale and sandstone, belonging, perhaps, to the Ponent Series, or to the thin remnant of the Umbral. The rock itself, in the road-ditches, &c., seems full of ferruginous moisture. No ore stratum, however, has been discovered. The best exposures of the rock are on the road from Smethport to Coudersport, about 4 miles E. of Smethport. Here the bands of rock seem to have a thickness little short of 100 feet. It forms a soil derived from the green Ponent sandstones. Occasional specimens of red sandstone appear. Many pieces are red outside, and encrusted on one or both sides with iron ore, while within they are grey and yellow, and filled with what might be taken for fossil cavities, but prove, when examined, to be but nodular cavities filled with yellow soil, and due to the abundance of ferruginous matter with which the rock is impregnated. The whole character of the band is ferruginous. There is little doubt that it has a relationship with the Marshfield ore-seam. It appears again on the Olean and Smethport roads, a few miles from Smethport; and 4 miles from Smethport, on this road, the band forms a bold escarpment 60 feet in height, the bottom of which is from 60 to 80 feet above the Creek. Again it appears on the Merain Creek, up which passes the turnpike to Bellfonte *viâ* Ridgeway. The red soil is here covered in patches with white sandstone, the Seral conglomerate from the adjacent heights. Again it is seen along the base of the Tunamaguont slopes, and with the same characteristics of rich chocolate-coloured soil and bold-terraced hill-sides.

In the upper part of this band of red rocks (the exact position could not be ascertained—probably at its extreme upper limit) is found, at Judge Otto's, a seam of good bright coal a few inches thick; and at a place upon Potato Creek, several miles above Smethport, in a little ravine on the W. side.

Limestone.—Not many feet above this, and about 200 feet below the conglomerate, are found in numerous places evidences of a persistent band of limestone. It occurs, for instance, on the hill-side, near the road from Potato Creek to Tunamaguont Settlement, and about 6 miles N. of Smethport, where a copious spring issues, charged with lime, which covers the stones and grass with a calcareous tufa. Similar springs issue upon the Warren Road, 6 miles W. of Smethport. On Bunker Hill, on the Bellfonte Turnpike, a specimen of fossiliferous limestone was found occupying this position in the series, under an exposure of very hard whitish Vespertine sandstone, dipping 7° S.S.E.

The bed itself was discovered beneath a cliff of similar hard whitish sandstone, 30 feet high, upon the run which enters Potato Creek from the Westward, 10 miles S. of Smethport. This limestone is 4 feet thick, exceedingly fossiliferous, very hard, and very sandy, being in reality a sandstone filled with fossil shells. It will sometimes make a sufficiently good lime for agricultural purposes. It seems to have been deposited over a wide area, as we discovered it upon Bennett's Branch to the S.; while there can be no good reason to doubt

that the same band makes its appearance upon the Tioga River and Pine Creek, and even on Towanda Creek to the E. It has been recognised also upon the Tunamaguont Creek to the N.W.

The Vespertine sandstone series, in the base of which this calcareous stratum occurs, is upon the Driftwood, at the third axis, about 400 feet in thickness; but, dwindling to the N., is little more than 150 or 200 feet in thickness at the New York line. At the same time it loses its distinctive lithological character, and, assimilating to that of the Vergent series (the Ponent being thin), the two often fuse, as it were, into one mass.

Fossils common to the Vergent series occur upon Bunker Hill, in the neighbourhood of the limestone above described, in exposures of green sandstones continuous with the Vespertine rocks. The lower strata of this series are in some places fit for building purposes. A quarry of fine slab-stones has been opened near Coudersport; grindstone slabs of excellent quality are obtained near Smethport, in the lower Vespertine strata.

The Umbral red-shale formation has nowhere been fully opened, but everywhere gives evidence of its existence as a very thin stratum of variegated shale, accompanied by its well-known iron-ore. The places where bog-ore is found issuing from under the conglomerate are too numerous to mention. A few of the most important are at the Red Mill, near Instantur, in the Fifth Basin, and along the N. dips upon the ridge between Smethport and the Warren Road; also on the Potato Creek and Tunamaguont Road, and 5 miles S. of Lafayette. Six miles N. of Smethport the ore itself was obtained. Here a vast bog covers the slope of the hill-side, while a copious spring issues from under the conglomerate, and within 50 feet of the top of the ridge.

Multitudes of these ferruginous bogs occur at the same elevation for miles W. towards Tunamaguont Creek. The ore was found by an unskilful digging continued for a month. It was an ore with a white core of a very fine texture. This place should certainly be opened thoroughly, as it is upon the N. limit of the ore, which here seems to give evidence of being of considerable value. It is on the stream coming in from the W. above Judge Otto's residence.

The Seral conglomerate is here sometimes a fine-grained conglomeritic sandstone, containing elongated pebbles, sometimes merely a flinty yellow sandstone; but in the neighbourhood of the Smethport and Ridgeway Turnpike it is almost wholly a white massive sandstone, with conglomeritic layers at wide intervals. Upon the Tunamaguont Creek, on the contrary, one may remark pebbles imbedded in it, as upon Burnett's Branch, as large as an ostrich's egg. Such localities are remarkable, and the relations they bear to each other and to the rest of the area of the formation are worthy of study.

The fifth great anticlinal crosses the State line at the Genesee River, and ranges S.W. to Potato Creek, which it crosses S. of Smethport, N.N.W. dips being found in the neighbourhood of that town. Its course is thence up the valley of Marvin Creek to its head-waters. Passing through the water-shed between Marvin Creek and the waters of Toby Creek, or the West Branch of Clarion, it is lost in the wilderness country to the W. and N.W. of Montmorency, though its range S. carries it S.E. of Blood's Settlement (Marien) to the Clarion River. All the strata upon the N.W. side of this line are therefore thrown into the Sixth Basin, while those to the S.E. appertain to the Fifth.

The first appearance of Coal-measures in the Fifth Basin within the borders of McKean County is on the high land between Potato Creek and Alleghany River. It has been proved upon the lands of Mr Backus, within an area circumscribed by conglomerate, but what its extent is we have not been able to learn. Whatever is there found must evidently occupy a position low in the series.

At Smethport, Red shale occupies a large space on the hill-sides, at or near the tops of which conglomerate crops out. On the surface, about 2 miles W. from the town, are thickly-strewn blocks of this rock, many of them of great size, consisting of coarse and pebbly sandstone and Nut and Pea conglomerate. These are, no doubt, derived from the adjoining hill: it is probably 200 feet above the road-level itself, and much more above the level of the town. Associated with the Red-shale fragments is green shaly sandstone, and some of the dark ragged and pebbly rock. The Ponent Series (if it is correctly identified) in this vicinity cannot be less than from 150 to 200 feet thick.

The identity of the Red shales and sandstones with the Ponent series is a question of the more importance,

because this series, traceable over an extensive area, supports in parts of McKean County, as in more Western districts, a small coal-seam, which outcrops along a well-defined terrace, and even intimates its presence by a smut upon the Olean Road, 12 miles from Coudersport.

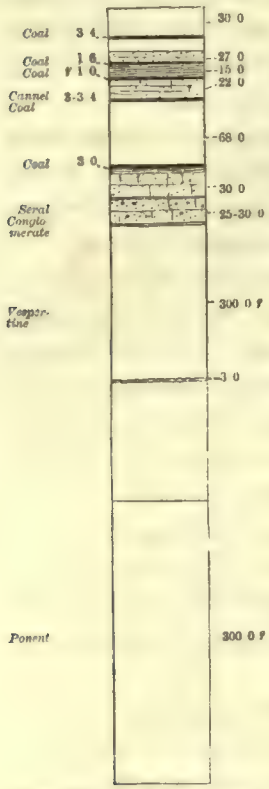


FIG. 380.—S. of Smethport. 1 *inch* = 200 *feet*.

Upon the upper waters of Potato Creek we are fairly in the Coal-measures.

The following section (Fig. 380) and notes of the stratification about 2 miles S. of Smethport have been in part furnished us: we cannot vouch for their accuracy.

Coal, dull and bright alternately, 3 feet 4 inches; Sandstone, &c., 27 feet,; *Coal*, 1 foot 6 inches; Slate, 15 feet; *Coal, in boring*, 1 (?) foot; Argillaceous sandstone, 22 feet; *Cannel Coal* (in boring 5 feet), 3 feet to 3 feet 4 inches; Interval, 68 feet; *Coal*, 3 feet; Sandstone and slate, 30 feet; Conglomeritic white sandstone, 25 feet to 30 feet; Vespertine strata, including 3 feet of limestone.

The upper coal was proved by a shaft sunk through shale 9 feet; it contained no layers of slate. The roof is a dark slate, 6 inches thick, and over this are 18 inches of argillaceous iron-ore in flat balls and plates. Beneath the coal are 3 feet of fire-clay.

The next coal, proved by a drift 42 feet long, is 18 inches thick, and contains one foot of good coal; the rest is slaty. This coal, bored into twelve rods from the drift, appeared to be 3 feet 4 inches thick.

The Fourth Coal, or that next in importance, was found by boring near the drift above mentioned, and proved 5 feet in thickness; but in a drift half a mile distant, where the coal had a covering of 18 feet, a seam, thought to be the same, measures but 3 feet 4 inches. The lower 3 feet of this bed is cannel coal; the upper 15 inches is soft coal, probably of the cannel variety. The lowest coal under a cover of 10 feet shows a thickness in a shaft of about 3 feet.

A Section of the hills upon the E. side of the creek, 3 miles from Norwich, is exhibited in the annexed woodcut (Fig. 381). The lowest bed was opened under a small cover and proved there to be little more than 3 feet thick: over it is seen the debris of a heavy sandstone. The coal itself is tolerably good, but intermixed with slate and slaty coal. It is better than a bed occupying a similar position near Coudersport, but not so good as farther W. The upper beds are marked by springs, bogs, and benches. In the springs, slate and some little coal have been found. The dip is S.S.W. apparently over 5°, and the outcrop of the beds seems to be the N. margin of the basin. S.E. of Norwich, between it and the Salt-works,* coal has been found upon the lands of the Monroe Coal and Iron Company. Mr Sheafer reports to have opened four small beds of from 1 to 2 feet thickness, and a larger bed, the fourth ascending, measuring 5 feet. A seam of cannel coal, 2 feet 10 inches thick, is said to be found in the same district.

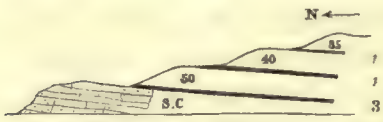


FIG. 381.—Potato Creek, 3 miles from Norwich.

Crossing Potato Creek to the high lands W. of it, still in the Fifth Basin, we come upon the coal-beds of the Bunker-Hill measures. The N. margin of the outcrop ranging from the Potato Creek somewhere near Norwich, the Smethport Turnpike crosses not far N. of Bunker Hill or Clermont Settlement; it then converges towards the fifth axis at the head-waters of Marvin Creek. Whether the Coal-measures lap over the fifth anticlinal between Marvin and Toby creeks is a point not yet determined; but should they do so, it can only be for a short range, inasmuch as they are again cut out by the deep valley of Toby Creek and its branches. The high ground between Toby, or the West Branch, and the East Branch of the Clarion, embraces coal strata S. to Johnsonsburg, which occupy nearly the centre of the Fifth Basin. S.E. of the East Branch of the Clarion, we have reason to believe coal may be found upon the more elevated tracts, as far as where it is denuded from the summit of the fourth anticlinal axis. W. of Toby Creek Coal-measures underlie the forest

* On the Portage Branch of the Sinnemahoning, 12 miles S. of the Alleghany River, boring commenced on Vergent rocks; augur broke at 350 feet depth; constant yield of a small quantity of brine. It was abandoned in 1852.

country at its head-waters, except where cut out by the deepening valleys of those streams. They appear even to cross the fifth anticlinal, and occupy the high rolling table-land in the Sixth Basin S. of the North Branch of Kenzua, and among the other waters of that stream. Between Marvin Creek and the N. Fork of Kenzua they embrace Howard Hill, and are prolonged N.E. to within 7 miles of Smethport. We shall hereafter show the distribution of the coal strata N. of the Kenzua.

Returning now to the Bunker-Hill neighbourhood, we find the coal-beds opened by Mr Beckwith, as represented by the vertical column (Fig. 382). The limestone at the top of the section is found on a piece of land one mile S. of Mr Renshaw's, and is evidently a bed in ruins. Many pieces lie in the ground, and one was obtained several feet thick. This last reposed in a bed of fire-clay, and that upon blue compact shale. In the hill S. of this the soil on the outcrop of this limestone stratum was thought to appear. The limestone is a very good fine-grained blue carbonate of lime.

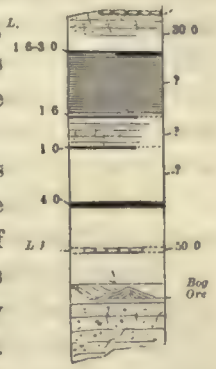


Fig. 382.—Instantur.

The upper coal is opened in Mr Beckwith's field, on the hill W. of the turnpike, and is said to have yielded excellent coal, varying from 1 foot 6 inches to 3 feet in thickness. The lower coal has been opened in two places. In one of these there were two equal bands of 2 feet each, with 4 inches of slate between. In the other, a few rods distant, the bed was 3 feet thick to the slate below, which had not been broken to see if still another band lay below it. Over the coal, in a stratum of slate, are heavy balls of bright sulphuret of iron. Near the openings is a large bog of ore soil which has been deposited from water welling out, most probably, from a stratum of blue carbonate of iron.

Several miles S. of Bunker Hill, near the turnpike, a heavy bed of bituminous slate has recently been opened. Although currently reported to be cannel coal, it has far more the character—if we may judge from specimens—of a highly-carbonised slate, or slaty cannel. We are unable to announce its precise thickness, but it is stated to be fully 14 feet.

Eight miles S.W. of the last locality a section was obtained on lands under charge of Judge Wilcox (see Fig. 383). The upper coal was opened years ago, by Mr Wescott, 1½ miles S.W. of Judge Wilcox's house. The bed was not under good cover, yet it displayed 3 feet of excellent coal. The next bed below has never yielded more than 6 inches of coal near the line of section, but is thought to represent a much larger bed. Some miles farther S.W. upon the old Jefferson County line, Mr Sweet opened a bed in two bands 2 feet apart, yielding 3 feet 9 inches of coal. This may be upon the horizon of the upper seam in the section, but we are disposed to consider it lower. On the high ground E. of Johnston's Run, a tributary of the East Branch of the Clarion River, and near Mr Miller's house, half a mile S. of the turnpike, there is a quarry of limestone. It was discovered by a sinking spring. As exposed, the stratum is 15 feet thick, but how much thicker cannot be told. The rock is fossiliferous, of good quality, hard and brittle, and makes a strong grey lime. It is of great importance to this country, otherwise very destitute of lime; it can find a market in the State of New York, and has been sold, we learn, in Olean. It ranges through the middle of the basin, but as it does not appear to produce the peculiar loamy soil, the colour of which is so indicative of the presence of a bed of limestone, it has been impossible to trace the bed; a little careful research will develop its large outcrop wherever it exists. Intimations of the presence of a bed are given on the Warren Road, 5 or 6 miles W. of Montmorency, but whether of the same bed or not, we cannot say; indeed, the horizon of this great limestone stratum is as yet very obscure. Our observations in its neighbourhood led us to place it low in the series, as the equivalent of the ferriferous limestone; but the developments made upon the Kenzua and Marvin Creek waters, farther N., have failed to detect its presence, and those who have conducted local surveys there, regard it as very high, and perhaps even overlying the entire series in those parts. At some future day, when the stratification beneath it has been determined, a reliable key to its position will be furnished, and the bed will be opened elsewhere. The coal-bed next below the limestone was not opened in such a manner as to insure the development of its whole thickness. The iron-ore band beneath this may prove

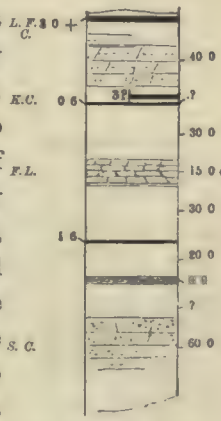


Fig. 383.—Judge Wilcox's.

of importance. It was discovered on two brooks, lying in long flattened balls, weighing from 20 to 30, or even 50 pounds, and some of them having a maximum thickness of 9 inches. It is a blue carbonate, rather coarse in the grain, and if found in more than one such layer, will be worth working. The rock lying beneath this series is a massive white sandstone from 60 to 100 feet thick.

At the confluence of the East and West Branches of the Clarion, at Johnsonsburg, three beds of coal have been opened on Dickinson's land by Mr Jesse Kyler. The lowest of these, lying close to the conglomerate, is 2 feet 10 inches thick at one opening, but at others does not exceed 1 foot 6 inches. The second bed is 16 feet higher, and measures 1 foot. The third is perhaps 60 feet above the last, and proved to be 4 feet 10 inches in thickness. It occupies a high position in the hills, and covers but a limited area in this neighbourhood. They all dip gently S.E. The same beds of coal have been opened on Dickinson's lands, 1½ miles S.W. of Ridgeway. Here the top bed is only 6 inches thick; the others are 20 inches and 1 foot respectively. On Spring Creek, near the county-line of Forest, the same beds are ascertained to exist. Two miles E. of Montmorency, a coal-bed, said to be 5 feet thick, was opened years ago.

On the E. bank of the Clarion, below Johnsonsburg, a bed of splint coal, or a mixture of coal and slate, has been opened about 40 feet beneath the Seral conglomerate, and there are indications of others.

We shall presently see that the three coal-beds above mentioned occupy nearly the same relative position in the neighbourhood of St Mary's.

St Mary's.—On the lands of the Ridgeway farm and Coal Company, near St Mary's, coal has been opened at various points. On the low ground at Iron Run, in the village, the Seral conglomerate makes its appearance as a somewhat coarse-grained yellowish sandstone, with ferruginous streaks. Some of the beds are slightly conglomeritic. Upon this coarse sandstone reposes a pure white silicious sandstone, the freshly-broken surfaces of which present an appearance not unlike that of loaf-sugar. This rock may be seen on the brook which flows by the Theresa Street Mines.

The annexed vertical Section exhibits the stratification at St Mary's (see Fig. 384).

On Theresa Street, above the sandstone, three beds of coal have been opened; the lowest is 12 or 15 inches in thickness. In the slates immediately above this coal, balls of dull white or grey carbonate of iron have been found. The quality of the ore is excellent, but the openings have not been sufficiently extended to ascertain its quantity. Not more than 15 or 20 feet above this bed occurs another coal, measuring 18 inches, above which a thick stratum of ore has been proved. Oval flattened masses of blue carbonate of iron repose in close contact within a thickness of from 2 to 4 feet, and masses are found in the slates still higher. 30 or 40 feet higher, another 18-inch coal-bed is opened. None of these seams have been mined at the localities mentioned.

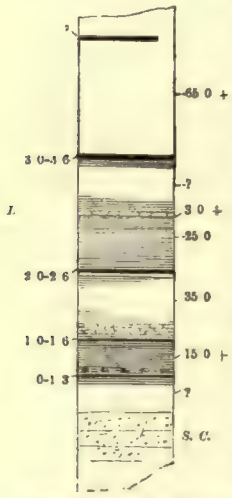


Fig. 384.—St Mary's (Fifth Basin).

On the Monastery lands W. and N.W. of the Catholic church, two of the coal-seams to which we have been adverting have been opened. The upper is 2 feet or 2 feet 6 inches thick, the lower from 12 to 16 inches.

On the higher grounds, in the S. and W. parts of the town, limestone is found at various places. It is a very hard dark-blue rock, and burns to a light-grey strong lime. The thickness of the stratum has never been tested, but it certainly exceeds 3 feet. The presence of this bed adds greatly to the value of these lands for agricultural purposes. We have before expressed our conviction that it is the same stratum which lies at the base of our section at Kyler's, on Little Toby Creek, and it may prove to be the S. prolongation of the great bed seen at Wilcox's. It appears on the Olean Road, near St Mary's, and is evidently beneath the bed of coal that has been mined E. and N.E. of the town.

The principal openings on the coal-bed over the limestone are those of Allis, Nist, Bucheit, Glot, and Anthony, in which its thickness varies from 3 feet to 3 feet 6 inches. The roof and floor of the coal are usually thin bands of bituminous slate. The same bed was cut in Corbe's Well, and may readily be opened at various points on the hills. From 60 to 70 feet above this bed there are indications of a coal-seam, but it has never

been fairly opened. It was seen at Nist's Spring, near his house, and not far from the road on Bucheit's land. The bed is apparently thin. The limestone stratigraphically under these beds is opened on Mr Shaeffer's farm, N.E. of St Mary's. The entire stratification in the vicinity of the town is gently N.W., towards the axis of the Fifth Basin. Coal displays itself on nearly every hill between St Mary's and Roselay. It has been opened at several points by Mr Hanhauser; but at Roselay the coal strata are thrown off from the back of the fourth anticlinal.

On Elk Creek, near Mr Garner's barn, in the village of St Mary's, there are indications of a small deposit of bog-ore.

Owing to the gentle undulating dip of the Seral conglomerate W. towards the Clarion, the coal strata do not appear to increase in thickness in that direction. To the same fact is attributable the absence of Coal-measures bordering the Centreville and Ridgeway Turnpike W. of the fourth axis.

On the Clarion River, 1 mile below the mouth of Little Toby Creek, and about 20 rods above that of Bear Creek (Beaver Creek on the map), there occurs on the E. side of the river a fine deposit of bog-ore. The Seral rocks, descending, here occupy the middle third of the hill, and form a stratum at least 100 feet in thickness. Five or six springs, in a space of about 30 roods, issue along the lower edge of this rock, each of them depositing the pulpy red oxide of iron along the slope leading down to the river. Probably 20 acres are covered with the deposit, the average depth of which may be given at 7 feet. The coarse conglomeritic sandstone above is exposed, but the more flaggy Umbral beds show themselves at the base of the hills, where the contact of the two formations is clearly marked by an abrupt change of slope at the level of the springs. Huge blocks or masses of the overlying rock have detached themselves from the body of the stratum along the face of the hills. Though partly conglomeritic, the largest pebbles rarely exceed a hazel nut in size. The hills rise about 100 feet higher than the upper edge of the conglomerate, and about half-way in this interval, or some 50 feet below the summit, occurs an indentation or bench which may possibly imply the existence of a seam of coal.

On the hill, ascending by the turnpike E. from Ridgeway, the fine white clay, mixed with minute fragments of red shale and fine-grained iron-ore of the Umbral formation, may be seen. It is from this clay that the springs issue which, up and down the Clarion, deposit the bog-ore we have been describing.

CHAPTER XII.

THE SIXTH BASIN SOUTH-WESTWARD.

THE general character of the Sixth Basin, in the central and W. parts of M'Kean County, is that of a wild rolling upland, drained by the constantly-deepening channels of the tributaries of the Alleghany River flowing N. and W. Until within a very recent period it has received but little attention, and our explorations within its borders were governed by the few widely-separated openings upon coal, and the sometimes doubtful identification of the coarser rocks which mark specific horizons of deposit. Within the past two years the extensive surface-explorations of Mr A. F. Dalson upon the lands of the M'Kean and Elk Improvement Company, and of Professor Owen, Professor Hall, and others, upon the Tunamaguont waters, have guided us to a more accurate knowledge of the stratification. The full development of all the beds of coal, with the included bands of shale, slate, sandstone, &c., was long ago felt to be a desideratum, and to this we have now in some degree attained.

The following section, furnished by Mr Dalson, embraces the series of coals and intervening measures found to occupy the higher hills at the head-waters of the South Branch of Kenzua Creek in ascending order :—

Strata undeveloped, including three small beds of coal, occupying a high knoll on County Warrant, No. 3131, 60 feet.

1. *Coal*, slaty, 2 to 4 (?) feet, usually called the "Splint Bed;" sandstones, and black and green shales; ore in lower part, 38 feet; sandstone and shale, iron ore at bottom, 15 feet; sandstone, fine-grained and ferruginous shale, 13 feet; nodular iron-ore in compact bed, 5 feet, known as the "Rockwell Ore" stratum. This we regard as the

base of the Umbral formation. Below this succeed brown and olive sandstones, and a band of pebbly sandstone or conglomerate, beneath which is found a stratum of bluish-grey fossiliferous limestone, 5 feet thick, occupying a low position in the hills along the deeply-cut ravines. We have shown in the previous chapter that this is a persistent band of limestone, being found in various parts of M'Kean County, and S.E. upon Bennett's Branch.

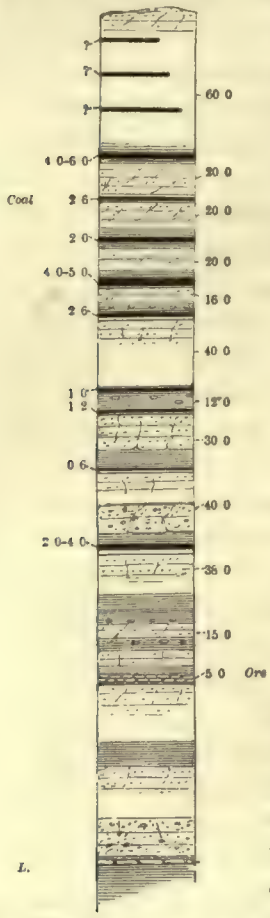


FIG. 385.—Head-waters, South Branch Kenzua Creek.

2. *Coal*, 6 inches; shale and iron ore beneath; compact white and pebbly sandstone (Seral conglomerate), 40 feet.

3. *Coal*, 1 foot 2 inches; compact grey sandstone, 20 feet; ferruginous shale and fire-clay, 10 feet.

4. *Coal*, 1 foot; slate and shale ore-balls, 12 feet.

5. *Coal*, 2 feet 6 inches; fire-clay, fine and coarse sandstone (Tionesta sandstone), usually denominated "the Pink sandstone," 40 feet.

6. *Coal*, 4 to 5 feet, including slate and clay partings, 6 to 6 feet 6 inches. This is regarded as the equivalent ofthe Bond Seam of Lafayette.

7. *Coal*, bituminous, 2 feet; slate-sandstone and slate, 20 feet.

8. *Coal*, cannel, of good quality, 2 feet 6 inches, including a layer of bright bituminous coal at the bottom; flaggy sandstone and shales, 20 feet.

9. *Coal*, of good quality, 6 feet; this is probably the equivalent of the uppermost bed proved N.E. of Howard Hill, on Warrant No. 2665, where it measures 4 feet; also of the L. Davis Bed, 5 feet thick, at Lafayette; fire-clay and flaggy sandstone, 20 feet.

The full series of strata embraced in the above section are found only on the higher points at the heads of the streams in the central parts of the basin N.W. of the fifth anticlinal. The usual covering of the district we are describing, S. of the North Branch of the Kenzua, is the second great Coal-measure rock, the Tionesta sandstone, which has served to protect the coal strata lying beneath it, and above the Seral conglomerate, as shown in the diagram (Fig. 385). The precise areas occupied by the upper coals can only be determined by careful research and the use of instruments.

The so-called "Splint Seam" belongs to a group of coal strata which, although appertaining to the true Seral coal-formation, were long ago recognised as lying beneath the main body of the Seral conglomerate. In a future chapter this group will be shown to embrace one, and sometimes two, important beds

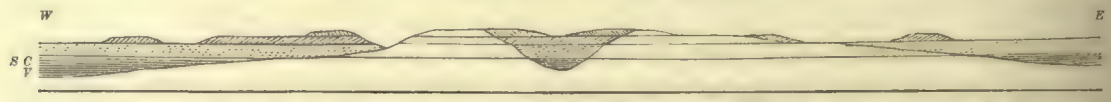


FIG. 386.—Section exhibiting the two Sandstones overlying the Seral Conglomerate W. of Smethport, with the Coal between.

of coal. Though the bed is frequently a mixture of coal and slate, as its name implies, it is generally estimated among the workable coals of the region, and, as such, will be accepted as the horizon for defining the coal areas N. of the North Branch of Kenzua Creek.

N.W. of Smethport a small patch of Coal-measures is found occupying the high ground S. of Cole Creek. This may be an insulated area, or is probably connected with a more extended field, the outcrop of which is met on the road between Smethport and Lafayette, about 4½ miles W. of the former place. From this point the S. outcrop observes an irregular course, determined by the conformation of the surface, bordering the valley of the North Branch of Kenzua Creek, from which it gradually recedes, passing S. of Lafayette and N.W. towards the Alleghany River, at the head-waters of Sugar Creek. Passing some miles W. of Marsh's Corners, among the head-waters of the West Branch of the Tunamaguont the outcrop deflects E., and crosses the Tunamaguont Creek to the place of departure. We have thus an area of about 15 miles in length and 5 in average breadth occupied by coal.

Estimating in a rough way the entire thickness of the coal strata as developed from the conglomerate border of the coal area towards the central parts of the basin—as, for instance, from Davis's Sawmill S.W. of Lafayette

towards the latter place—we think there are not less than 200 feet of rock, including several beds of coal. The Seral conglomerate, as exposed near the sawmill, is a coarse white sandstone ; some layers are full of small pebbles of the size of peas and millet-seed.

W. of the Tunamaguont, and N. and N.W. of the general coal area which we have indicated, several small patches of coal are found separated from each other by deep watercourses. Such an one is that embraced by the two main branches of Sugar Creek. This tract occupies a flat summit about 2 miles in length from E. to W., and three-fourths of a mile wide at its W. extremity. The position of the only bed of coal that has been developed upon it is more than 30 feet above the upper edge of the Seral conglomerate or sandstone, from which it is divided by that thickness of coarse brown shales. The shales probably embrace one or two small beds of coal. The coal itself is about 15 inches thick, and has a dull aspect and slaty impurities. It is immediately overlaid by about 12 feet of dark-brown shale, in which are scattered a few small nodules of argillaceous iron-ore. The more elevated points of this district contain the lower part of the Tionesta sandstone, which rests immediately upon the brown shale, and is of a grey or yellowish colour, and sometimes much blotched and streaked with peroxide of iron (see Fig. 387) ; of which it is to be observed, in common with the four following sections, that it represents the only coal-bed known to exist between the Tionesta sandstone and the Seral conglomerate at the date of our earlier surveys. Subsequent researches have furnished a key which may lead to the development of others. The higher hills on the N.E. of the main Kenzua Creek appear to be capped by this upper sandstone, though the distance between it and the bed at the base of the formation is so small that we seldom obtain exposures of anything between them.

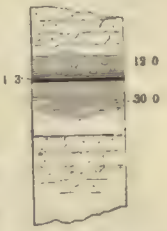


FIG. 387.—Tunamaguont.

Similar insulated areas of coal strata to that above mentioned occupy the higher grounds W. and S.W. of Littleton, upon the waters of the W. branch of the Tunamaguont Creek ; but the precise superficies covered by coal we have not ascertained. Most of these summits are capped by the Tionesta sandstone, though some of them are high enough to embrace one or two coal-beds lying above that rock. The Seral conglomerate ranges high in the hills, even beyond the State line into New York ; and the coal beneath it may be found at points not within the limits of our description.

The deeper parts of the Sixth Basin, within the area previously designated N. of the North Branch of Kenzua Creek, embraces the same series of Coal-measures which we have given in our description of the country S. of that stream. The published Geological Sections of Messrs Owen and Needham represent the same beds of coal, though under somewhat variable conditions as regards the thickness and nature of the intervening rocks, and of the individual coal-beds themselves. One or two coal-beds are enumerated by them as having a probable existence, for which we find no place in our section, nor have the seams of black shaly ore denominated "black-band" by those gentlemen been found to have a traceable persistency. The most important of these is reported to occupy a position in the shales between coals 3 and 4 of our enumeration. The coal-beds, Nos. 1, 5, 6, and 9, known as the Splint, Whitman, Newell, and Davis beds respectively, are all estimated as containing fully 5 feet of coal, except the first, which contains 4 feet.

Among the well-known coal-beds which were opened prior to the local surveys above alluded to, that of Mr Bond is worthy of mention. This bed contains from 4 feet 6 inches to 5 feet of coal, subdivided into 4 benches, with slate-partings of a few inches thickness. The second bench from the top is a cannel coal 18 inches in thickness. At Tildon's, near Lafayette, a similar bench of cannel coal is found included within a larger seam of the ordinary bituminous variety. The bituminous coal of this bed yielded, on analysis, 37½ per cent of volatile matter.

Coal has been opened on Mr Owen's land one mile S.E. from Mr Bond's, on Three-mile Run. Here two beds have been proved ; the upper by a drift carried in 80 or 90 feet, the lower by a shaft sunk about 20 feet to the bottom slate. The two openings are about 170 feet apart. The thickness of both beds is 3 feet ; the lower bed is good bright bituminous coal of clear fracture, without any bands of slate. It is underlaid by fire-clay, and overlaid by 10 inches of blue roof-slate, and over this 9 feet of slate, capped in the shaft by earth and rubbish. It is thought that the interval between the two seams does not amount to more than 10 feet of slate.

The coal opened in the drift is likewise 3 feet thick, the upper half cannel coal, and the lower bituminous.

At an interval estimated to be about 25 feet above the coal last mentioned, there is another which, at the outcrop, showed a thickness of 1 foot of cannel coal. It lies in a bench near an abrupt rise of sandstone. It is probable that the seam is thicker than its outcrop indicates.

There appears to be another bed of coal, about 40 feet beneath the lowermost of the three seams above mentioned. It has not been fully proved, but sufficiently so to show a bed of some promise. The fragmentary coal at the outcrop is pure, and of the bright bituminous kind.

W. of the Alleghany River we find a small patch of the Seral conglomerate near the heads of Pine Creek, about 3 miles S. of the New York State line, and nearly the same distance from the river. It is only a small insulated tract 1 or 2 miles in length, which has escaped denudation. It lies N. of a larger tract occupying a considerable area between the Alleghany River on the E. and Hemlock Run on the W., and extending 6 or 7 miles W. from the Alleghany River. It forms the river-hills on both sides of the mouth of Hemlock Run N. for about the same distance. E. of the head of Hemlock Run, and about 3 miles to the W. of Kenzua, is the only patch of coal found upon this fragment of the carboniferous table-land. It occupies only the highest summit, and its whole area does not probably amount to 1 square mile. The plane of the coal-seam is above the Seral conglomerate: its thickness averages at least 2 feet. Nowhere has it a covering of more than 50 feet of overlying shales and lower beds of the Tionesta sandstone.

N. of Warren there are three isolated knobs of the sandstone, upon which no traces of the coal-seam occur. One of these is immediately back of the town; the second, which is larger, is on the E. side of the Connewango, and below the mouth of Pine Creek; the third is in Pine Grove Township, 2 miles W. of the Connewango, and 3 miles S. of the New York line.

Advancing to the S.W. of the Kenzua, the region begins to assume the more definite character of a regular coal-basin, bounded on the S.E. by a broad expanse of the great Coal-conglomerate, brought up by the fifth anticlinal axis; and on the N.W., next the Alleghany River, by a high belt of the same rock.

This description applies to the whole drainage, or basin of the Tionesta, with its tributaries. All the central tracts of this trough, from the Kenzua S.W. to Racoon Creek, have their higher summits overspread by the second great sandstone, and therefore contain at least the one small coal-vein previously described, and perhaps others of the Tionesta series. A bed of coal has been opened in a few places, but from the thinness of the seam, and its position near the tops of the higher hills, it can never become of much economical importance.

The usual place of the coal-bed which our sections exhibit, is from 50 to 60 feet above the top of the Seral conglomerate, the intervening space being shale and slate; above the coal there generally rests a few feet of

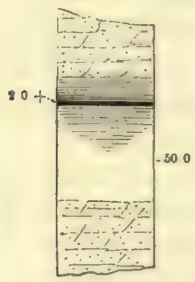


Fig. 388.—W. of Kenzua.

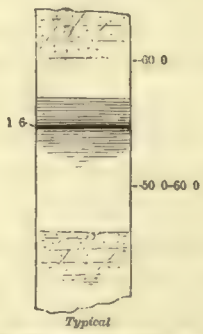


Fig. 389.—S.W. of Kenzua.

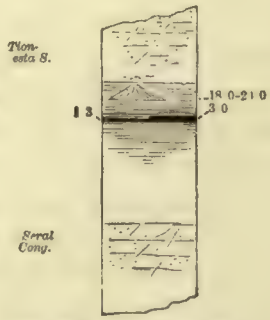


Fig. 390.—Little Alleghany River and French Creek.

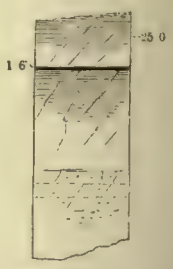


Fig. 391.—Near Franklin.

sandy shale, containing small scattered nodules of iron ore. Upon the shale lies the Tionesta sandstone, usually extending to the summits of the highest hills, the thickness of which rarely exceeds 60 feet.—(See Fig. 389.)

The usual thickness of the coal itself is about 18 inches. It has a dull aspect, and is rather slaty. It has been opened at its outcrop sufficiently to ascertain its thickness at Mr W. Johnson's, 9 miles E. of Warren, and 900 feet above the bed of the Alleghany; again in a hill about 11 miles S.E. from Warren, and bounding the Tionesta on the E., not far N. of the tavern on the Warren and Ridgeway Turnpike; again about 12 miles in a straight line due S. of Warren, where the coal is tolerably pure, but its thickness is only 15 inches.

Two miles S. of Kenzua there occurs, apparently in the Seral sandstone, which is 50 to 75 feet, and below the highest ground, a coal-bed 3½ feet thick, of which the upper 18 inches is cannel coal.

A bed of coal occurs in Quaker Hill on the W. side of the Alleghany River, about 8 miles above Warren; it is stated to be 18 inches in thickness, and of the ordinary bituminous variety, containing thin partings of slate. This coal lies in the Seral lower sandstone, or under the conglomerate.

About due S. from Warren 10 miles, and some 8 miles from the river, there is a bed of coal in apparently the same geological position.

The river-hills on the S.E. side of the Alleghany River display the following strata in the ascending order—(See Fig. 392):—

1. The upper portions of the Vergent or Chemung series some 300 feet or more. The fossil beds extend nearly to the upper limit of this group. No red or Ponent strata visible.

2. A group of generally thin-bedded sandstone, and olive-grey shale beds—some of the sandstone layers exhibiting a thickness of from 6 to 12 inches. These contain a bifurcating stem-like fossil perpendicular to the bedding, possibly a Coralline or a plant (?), and also a true Scolithus of the size of a thin quill, with a knob at the surface of the layer.

3. A massive quartzose conglomerate, with pebbles for the most part ovoid and smooth, and of the size of beans and small nuts. This bed is not more than about 10 feet thick.

4. Shales and thin-bedded sandstones 150 or 200 feet thick; they have the usual aspect of the Vespertine rocks of the Alleghany Mountain.

5. Fossiliferous sandstone, 10 or 15 feet thick.

6. At the summit of the hills a massive white sandstone, 40 or 50 feet thick. This is the Seral white sandstone.

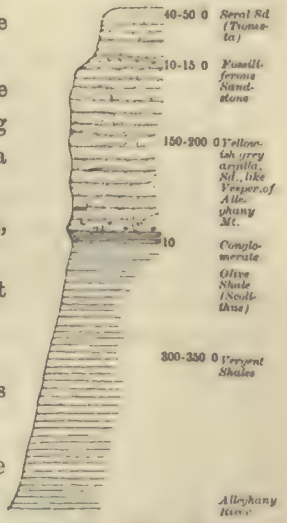


FIG. 392.—Hills S.E. of Alleghany River, near Warren. 1 *inch* = 200 *feet*.

About 4 miles S.E. of the mouth of Brokenstraw Creek, and 3 miles E. from the Alleghany River, there is a bed of coal consisting of two layers, as follows:—

Slaty Coal, 1 foot 6 inches; White Sandstone, 3 to 4 feet; Good Coal, 1 foot; Fire-clay with small balls of iron ore.

Many of the hills N.W. of the Alleghany River are capped by the Vespertine conglomerate, the Seral having been washed off.

On the S.E. of Brokenstraw Creek, the very highest hills are capped with a thin covering of Coal-measures containing the above-mentioned twin bed: the elevation of these coal-rocks above the river is between 400 and 500 feet.

Bog Ores.—Several deposits of bog-ore are to be met with in this belt of country: one of these is at the head of a small stream about 4 miles E. of Warren, a little back from the S. bank of the river. The amount of ore was not ascertained, but it did not appear important. Another more considerable body of the ore lies near the main stream of Hickory Creek: this appears to be a tolerably rich one. Other small collections of similar ore are seen N. of the forks of the Tionesta on the Ridgeway Turnpike; but these, and some others that might be mentioned, are too unimportant to be useful.

Very similar to the Tionesta portion of the basin is the geology of that division which lies to the N.W. of the Alleghany River, between Warren and the valley of French Creek.

Seral Conglomerate, North-West Limit.—By an inspection of the Geological Map it will be seen that the N.W. margin of the Seral conglomerate separates naturally into three tracts: that farthest to the N.W., forming the skirts of the basin, consists of a series of detached outlying patches.

The middle tract is a nearly continuous belt extending in a S.W. direction from the Brokenstraw near its mouth to French Creek. The third is formed by a range of broad detached summits, capped by the Tionesta coal, and stretching along the N.W. side of the Alleghany, from below the mouth of the Tidioute to the mouth of French Creek.

The most N.E. outliers of conglomerate are a few small knobs immediately N. of the Brokenstraw, and one near the Little Brokenstraw, 3 miles S.E. of Lottville. Two others of large area lie W. of the main Brokenstraw in Spring Creek Township. The most remote outliers are three low elongated hills in Randolph Town-

ship, W. of Centreville. S.W. of these are several small patches in Wayne Township. Two or three lie N. of Sugar Creek Lake, and three more W. of Little Sugar Creek. N. of Meadville are the College Hills, Huidekoper's Hill, and another a mile farther N. Besides these principal isolated tracts containing the rock in site, there are many localities in the district where it occurs in loose angular blocks of considerable size, which seem to have been displaced but a short distance from their original bed. These are most common between Centreville and Meadville.

The more continuous belt of the sandstone, or middle division of the district, is a nearly unbroken table-land throughout all its central portion; but around the forks of Oil Spring Creek, and again between Sugar Creek and the river, it is broken by numerous valleys and ravines, so as to form a succession of detached summits.

Tionesta Coal Group, North-western Limit.—The only coal-bed of this group hitherto developed with the overlying Tionesta sandstone, occupies a range of six or seven broad and elevated summits on the N.W. side of the river. The most Eastern of these is the river hill, North of Hickory Town; another spreads from Hickory Creek and the river Westward to Pitthole Creek; between this latter and Oil Creek there are two other large patches, one W. of the head of Pitthole Creek, and the other nearer the river in Windrock Township. Between Oil Creek and the mouth of French Creek are three other elevated outliers of the coal, the largest lying to the E. of Two-mile Creek; the next immediately N. of Franklin; and the third, and smallest, a short distance to the N. of the latter. In all these patches, the coal itself has been opened in only three places; but the observer may assure himself of the existence of the Tionesta Bed in each of the summits mentioned, by tracing the overlying shale and sandstone strata from one to the other.

The coal has been opened two and a half miles S.W. of Lamb's Tavern, which is 20 miles from Franklin on the road to Warren. Another opening is a little E. of Oil Creek, about a mile N.W. of the same road, and 14 miles from Franklin. Here the seam consists of a black friable coal shale rather than a true coal: it is about 3 feet thick. This locality is on the summit of a hill, and is covered by only 3 feet of soil. A third is 5 miles N. of Franklin, on the Cooper's Town Road. At each of these points the bed does not much exceed 15 inches in thickness. Over it rests 18 or 20 feet of blue shale, capped by the lower beds of the second sandstone. In these several particulars it accords exactly with the same seam, as seen in the Tionesta portion of the basin.

Bog Ore.—A small deposit of bog ore exists near the head-stream of Stewart's Creek, and a coarse nodular ore may be seen in the Warren Road, 3 miles to the N.E. of the mouth of Oil Creek, at the top of the hill, and immediately below the Tionesta sandstone.

North-Western Limit of the Sixth Basin, from French Creek Westward to the Ohio Line.—W. of French Creek a more uniform intensity in the action of the denuding flood has left fewer detached outliers of the carboniferous strata. Thus far the Seral conglomerate, or the sandstone which represents it, has been viewed as the base of the coal series, and the Tionesta coal as the lowest bed. But in the neighbourhood of French Creek, and the country between it and the Ohio line, a new group of Coal-measures comes in under the great coal-conglomerate. A few miles to the E. of French Creek, we first distinguish these earlier members of the coal-formation, consisting chiefly of beds of brown and black shale, containing some few scattered nodules of iron ore and one or more beds of coal. In this vicinity only one bed has been met with, and that of minor importance, but it becomes a valuable seam proceeding Westward. Its distance from the base of the sandstone is variable, but generally increases as the beds which separate them become more arenaceous.

The most Eastern localities where this coal-bed was discovered were those of Pine Knoll in Wayne Township, near Little Sugar Creek, and on the County line one mile S.W. of Sugar Creek Lake. In the former locality it consists of 15 inches of inferior coal, with a dull lustre, separated from the base of the conglomerate by 10 or 12 feet of brown and black shale, through which are scattered a few small nodules of very compact argillaceous iron-ore. The floor of the coal is likewise formed of brown shale, apparently free from nodular iron-ore. At Sugar Creek Lake the bed is about the same thickness, consisting of bituminous slate and impure coal; it lies at about the same distance from the overlying sandstone, brown shale being interposed.

The whole thickness of these inferior Coal-measures may, in the country around French Creek, be estimated

at from 30 to 40 feet.—(See Fig. 393.) When the country to the Eastward of these localities becomes more cleared, this seam will probably be found to extend considerably farther, but probably nowhere as an available bed in the direction of the Alleghany River. It thins out Eastward, and is certainly absent at Oil Creek.

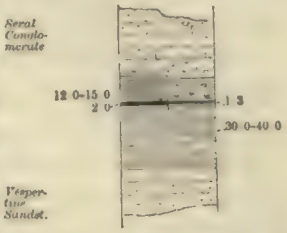


FIG. 393.—Sugar Creek Lake.

There are many other places, however, in the neighbourhood of French Creek, where this coal might be found by searching for it, at a proper distance below the base of the conglomerate. The particles of coal that have been found in the vicinity of Meadville and elsewhere, beyond a doubt belong to this coal-seam. These fragments have been broken from the edges of the bed on the sides of the hills, and brought down, together with other detrital matter, by the strong currents of water that have contributed to the denudation of the surface of the country. Fragments thus derived, but strewed over the surface of the country in the superficial soil, and there turned up in ploughing the fields around Meadville, have deceived many into the belief that some valuable bed of coal might be opened in the vicinity. Such a bed has been diligently, but, of course, fruitlessly sought, and even at considerable pecuniary loss. Indications of the Sharon Bed, above described, are met with in several places on the high plateau which enters Eastward from the summit of the College Hills, at an elevation of 400 feet above the bottom of the canal, and about 12 feet below the base of the great conglomerate. The interposed strata consist of beds of brown shale.

Proceeding Westward, the same coal-seam has been found on Deer Creek, in French Creek Township (Mercer County), about 4 miles from its mouth. It is here about 2 feet thick, and less slaty. About 12 or 15 feet of brown shale separate it from the base of the overlying Seral conglomerate sandstone which caps the hill. The coal is said to have been worked for the Meadville market, but the mine is now abandoned.

The high land about the head of Deer Creek, occupying a large part of French Creek Township, is likewise capped by the representative of the Seral conglomerate; and although the underlying Coal-measures were not noticed, their occurrence beneath it may be safely inferred.

In the Western part of Sandy Creek Township is a long ridge of elevated land, commencing about 2 miles S. of Conneaut Creek, and terminating 4 miles S. of Sandy Lake in Mercer County. The greater part of this ridge in Fairfield and Sandy Creek townships is occupied by the Seral conglomerate and the underlying Sharon Coal-measures. After crossing Sandy Creek, which cuts through this ridge, we come upon higher members, of which we will speak presently.

At Georgetown the conglomerate is found forming the highest point of land. The shale between it and the coal contains two deposits of good iron-ore about 1 foot apart—the upper one 7 inches thick, and the other, of a beautiful blue colour, about 5 inches. Beneath this shale containing the ore is the Georgetown Sharon coal-bed, increasing in thickness as we proceed towards the West, although it is by no means regular. In the immediate vicinity of Georgetown it is about 20 inches thick, but about 2 miles towards Greenville it is upwards of 3 feet thick. It is a slaty cannel coal of a dull jet-black lustre, and free from sulphur.

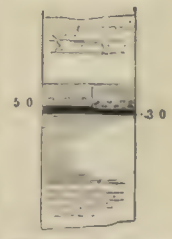


FIG. 394.—Georgetown, and 10 miles N.E.

Ten miles N.E. of Georgetown, and from three to three and a half miles due S. of Conneaut Town (on Tract No. 8 of Fielding's Draft), is a small outlying patch of the lower Coal-measures, covered only by a few feet of the lower beds of the Seral conglomerate.

The coal is a semi-cannel coal of slaty structure and peculiar lustre; it is from 3 to 5 feet thick. It is tolerably pure, contains no sulphuret of iron, and is said to be much liked by the blacksmiths. The bed is covered with shale and very argillaceous sandstone 12 feet thick, including one or two seams of iron ore, one of which is about 1 inch thick.

The bed of coal within the distance of 26 rods, in a S.E. direction, is only 1 or 2 feet thick. It is thin also upon the other side of the summit of the hill, which does not rise more than 15 or 20 feet above the plane of the coal-bed. It is wrought on this account with much difficulty. The selling price of the coal in Meadville varies from 17 to 18 cents per bushel.

Less than a mile S.E. of Greenville commences a broad and rather high ridge, which extends to within a short distance of the Shenango River, where it is joined by another similar ridge coming down from the N.N.E. These converging ridges form two sides of a triangle, occupied by the Seral conglomerate and the inferior Sharon measures.

All the high land around the head-streams of Otter Creek, and between it and the Shenango, are occupied by the same massive sandstone, which, gradually sinking to a lower level as it dips to the S.E., gives way to higher members of the coal-formation as we approach the town of Mercer.

West of the Shenango River.—Upon the W. side of the Shenango, a long ridge of elevated land commences about a mile E. of Kinsman (Ohio), and crosses the State line at the point where the Crawford and Mercer County line unites with it. Two miles from the line it forms an elbow, and then continues, in a nearly S. direction, to the head of a little run which empties into the Pymatuning, 2 miles above its mouth. Here it separates into two ridges, one passing within a mile of Greenville to the great bend of the Shenango opposite Lackawanna Creek; while the other continues its S. course to the Pymatuning. A little S.E. of the termination of the latter ridge, and on the E. side of the little run before spoken of, is a high tract of land nearly 2 square miles in area. The ridges just described are occupied by the Seral conglomerate and sandstone, which, gradually rising towards the N.W., are very sparingly spread upon the highest summits of the ridge in the middle portions of West Salem Township. The underlying Coal-bed has been opened in several places, at a distance of about 15 feet below the Seral conglomerate and sandstone. At Mr Lochslimmer's drift, 3 miles S.W. of the town, the coal is 240 feet above the bottom of the canal, which is about a mile and a half distant. Here also the coal is a species of semi-cannel coal, with a slaty structure and a dull jet-black lustre; thickness about 3 feet. Between it and the base of the sandstone is black bituminous shale, with vegetable impressions. The same seam has been opened four and a half miles to the E. of this, near Orangeville. Here it is about 14 feet below the Seral conglomerate, which rises to a considerable height above it. It is a slaty cannel coal, less than 3 feet in thickness, and has a local dip of 15 feet per mile towards the S.W. A mile and a quarter S. of E. from the last place, and on the Five-hundred-acre Tract of Captain Duncan, search has been made for this coal, and seven pits have been sunk at different levels, from which the following section has been made:—

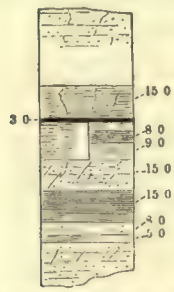


Fig. 395.—Two miles E., and three miles S.W. of Sharon.

Soil, 8 feet; Brown Shale, with a little iron ore, 8 feet; Black thinly-laminated Shale, 9 feet; Yellow and brown Sandstone, with vegetable remains, 15 feet; Black Shale, 15 feet; Slaty Sandstone, 8 feet; Brown Shale, 5 feet; lastly, Silicious Conglomerate, 60 feet underneath the true level of the coal, which was nowhere discoverable.

On the hills on the S. side of the Shenango, below the mouth of the Lackawanna, and about 6 miles N.W. of Mercer, coal has been found on the land of Mr Robert Flute; and 260 feet above the bottom of lock No. 15, overlooking the river, the hill itself rises 60 or 80 feet higher. Here the following section was obtained (see Fig. 396):—

Seral conglomerate; Sandstone, yellow, flaggy, fossiliferous, 5 feet; interval (containing Sharon coal?), 10 feet or more; Shale, black, brown, with iron ore, 7 feet; *Coal*, 8 inches (Sharon coal?); Grey Sandstone, slaty, with vegetable remains, 7 feet; Dark-coloured Shale, 16 feet; *Coal*, 15 inches; Shale, black, yellow, and brown, 15 feet; *Coal*, 2 inches; Chocolate-coloured Sandstone, 1 to 2 feet; Black bituminous Slate, 9 inches; *Coal*, 24 to 30 inches.

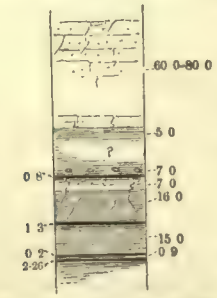


Fig. 396.—Six miles N.W. of Mercer.

A few hundred yards to the S.E. of this, on the other side of the summit, another shaft has been sunk to a considerable depth, without revealing any indications of the 2-feet coal-seam. Conjecture is at fault upon the identity of either of these beds with the Sharon coal, already described.

One mile N. of this locality, on the opposite side of the Shenango, several excavations have been made. Neither the 2½ feet nor the smaller seams above were found, although in other respects the stratification appeared to be very similar to that given in the preceding account.

Less than 2 miles E. of Sharon, on a high ridge, is a coal-seam 4 feet in thickness.

Below it are a few inches of bluish clay, and beneath that a hard, fine-grained, brittle white sandstone. The exposures are imperfect, but the coal is believed to be the same as that of Sharon.

About 2 miles W. of this last locality, on the opposite side of the deep ravine of the Shenango, is a high ridge, in which the Sharon Coal-bed has been opened, and skilfully and extensively wrought. The coal is near the top of the ridge, capped by the Seral conglomerate, between which and the coal are brown and blue shales, with argillaceous sandstone, 10 feet of which are exposed. The bed is 4½ feet thick, with a floor of black and brown shale (10 feet thick) resting upon grey slaty sandstone, and below that a coarse conglomerate formed of white pebbles of quartz. On the W. side of the ridge, at the distance of about three-fourths of a mile, the same coal is seen to outcrop 16 feet higher upon the E. side, showing a dip S.E. of 20 feet to the mile. The coal is probably 300 feet above the Shenango.

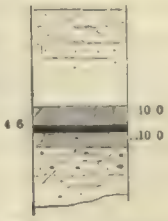


Fig. 397.—Curtis's Coal, Sharon.

The coal obtained at Clarksville is from the same bed, and is in every respect similar to it: it is good coal, free from sulphur, and occurs in masses of considerable size.

This seam is known to extend for some distance into the State of Ohio, and is probably the same with the Warren and Akron Coal-bed.

Some indications were seen of the final dying-down of an axis which would pass near the mouth of Mosquito Creek, having a S.W. and N.E. course; but as this did not cross into the State of Pennsylvania, no time was spent in ascertaining its existence; details connected with its appearance would, however, probably account for the line of outcrop of the coal-formation taking a more E. and W. course after crossing our W. State line. What becomes of the coal when the dip sinks it down to water-level towards the S.E. is not known. No indications were seen of it between Sharon and Pulaski, and at the latter place the conglomerate is but little above the water-level. It is not at all improbable that a bed of coal which has exhibited so much irregularity elsewhere should have altogether thinned out, or should exist only at undiscovered intervals. This want of uniformity appears in many places to mark in some measure the earlier periods of the coal-formation; for in the succeeding strata, which lie between the Seral conglomerate and the Tionesta sandstone (to be further described), very general confusion and want of regularity exist, both with regard to the coal-beds themselves and the strata which separate them.

We continue the details of the Tionesta group of Coal-measures above the Seral conglomerate, by returning to the neighbourhood of Franklin.

CHAPTER XIII.

THE NORTH-WESTERN SIDE OF THE SIXTH BASIN—(*Continued*).
THE TIONESTA COAL, FROM FRANKLIN WESTWARD.

The strata enclosed between the Seral conglomerate as their base, and the Tionesta sandstone as their upper limit, increase considerably in thickness W., and contain in Mercer County the most valuable bed of coal which there occurs. On both sides of the Alleghany River we see the Seral conglomerate, for several miles below the mouth of French Creek, at a considerable elevation above the water-level, standing out in bold relief upon the river-hills. No exposures occur underneath it for a space of 50 feet, at which level the Vespertine sandstone usually begins. All the country on the S.E. side of the Alleghany River, for 6 or 8 miles back, between the Tionesta and the mouth of Scrubgrass Creek (16 miles below Franklin), is occupied by the conglomerate and the Tionesta sandstone, with their intermediate shales and coal-beds. This tract, however, affords few or no exposures, and, with the exception of the deep ravines, like those of Horse and Hemlock creeks, is covered with a stunted growth of chestnut timber. The country lying N.W. from the Olean Road, about the heads of Racoon Spring and Millstone creeks, is overspread by the same rocks, and is but a continuation of the country lying to the N. of the Tionesta. The want of exposures, owing to the uncleared state of this part of the Sixth Coal-

basin, has prevented the collection of many facts relating to it. The Tionesta Coal is supposed to exist here between the two sandstones, but is not seen until we come into the neighbourhood of Tionesta village, where it has been opened. To the S.W. of the Tionesta, exposures are hardly more frequent. The Tionesta sandstone overspreads the general level of the country, and indications of the coal below it appear on Hemlock Creek. The coal seen in the vicinity of the heads of Pine Creek and Red Run belongs to this seam, as also that 6 miles S.E. of Franklin, on the turnpike. Here the coal is opened about 25 feet below the summit of a little knoll of black and brown shale, and proves to be a true cannel coal, about 20 inches thick, of good quality, burning freely, and looking much like slate, with a peculiar fracture and lustre, and containing vegetable impressions.

Bog Ore.—Upon Hemlock Creek, 3 miles from its mouth, there is a bank of bog-ore of considerable extent. It is said to cover 4 acres, and to be about 14 feet thick in the middle. Three beds of bog-ore occur 6 miles below, upon Horse Creek; they cover about 3 acres each. A bank of hard ore was at one time opened about 2½ miles from Horse Creek Furnace, and 3 miles from the river. The ore occurs in shale, and consists of nodules from 6 to 10 inches in diameter, with a thin black crust on the outside, and a yellowish nucleus. The opposite side of the Alleghany River, between Franklin and the mouth of Scrubgrass Creek, has been more fruitful in exposures than the country we have just passed over. For the first 5 miles, however, back from the river, fragments in great abundance have been detached from the Tionesta sandstone, and, sliding down the sides of the hills, have obscured in many places the strata which occupy a lower position. In French Creek and Sandy Creek townships, therefore, the strata which occupy the intervening space between the Seral conglomerate and the Tionesta sandstone have been traced with great difficulty.

The Tionesta Coal-bed is twice exposed—upon the river below the mouth of Six-mile Run, and 4 miles S. of Franklin.—(See Fig. 398.) At the latter point we find two veins, probably from 30 to 40 feet apart:

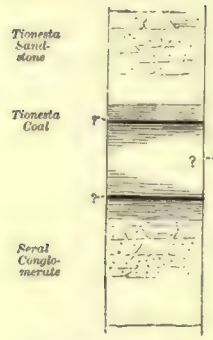


FIG. 398.—Four miles S.W. of Franklin.

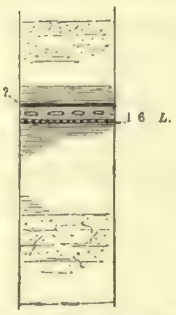


FIG. 399.—Three miles W. of Sandy Creek Furnace.

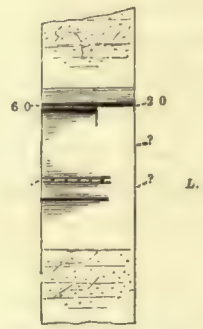


FIG. 400.—A. Henderson's, Law's, &c.

FIG. 401.—Sandy Lake.

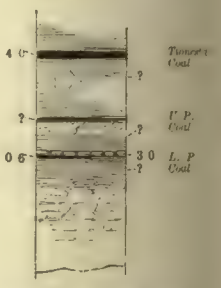


FIG. 402.—Three miles E. of Mercer.

the lower one rests upon brown shale, which is immediately above the Seral conglomerate. The coal itself is thin and poor; above it is argillaceous sandstone. The upper bed is a cannel coal, and enclosed in shales, over which is the Tionesta sandstone. The coal found on the E. side of the Alleghany River, and in the basin of the Tionesta, is supposed to be the continuation of the upper of these two beds. On a hill bounding Sandy Creek, and E. of the road from Franklin to Scrubgrass Creek, the Tionesta Coal has been discovered near the top of the hill. It is thin, and a considerable mass of the Tionesta sandstone rests above it.

Bog Ore.—At Sandy Creek Furnace, several small deposits of bog-ore are seen at the base of the Seral conglomerate, beneath which they have issued. One of the deposits lies upon a terrace of the hill behind the Furnace, and about 150 feet above the level of the Creek; it covers about three-fourths of an acre, and is from 3 to 11 feet deep, but averages, perhaps, about 4 feet over the whole area. The ore is bright yellow, light, with fine crusts, and commands at the Furnace 25 cents per ton. Three miles W. of the Furnace, hard ore, belonging to the same proprietors, is exposed at a distance of 25 feet beneath the base of the Tionesta sandstone, above a bed of blue argillaceous fossiliferous limestone, 15 inches thick. Above it are the following strata, ascending: Nodular iron-ore, 3 inches, immediately upon the limestone; brown shale, 3 feet; ore, 3 inches; brown shale, 2 feet; ore, 2 inches; coal doubtful—thin if present.—(See Fig. 399.) At Rheno's Furnace, on Big Sandy

Creek, bog-ore has likewise been found at the base of the conglomerate: it covers half an acre, and is about 10 feet deep. Its colour is dark, and if used with hard ore, in the proportion of three parts of the former to one of the latter, it is said to make good iron. Indications of the Sharon Coal-bed were noticed a short distance below the base of the Seral conglomerate. The hard ore, used at both the furnaces, comes from the shales belonging to this inferior coal group. These shales are situated below the level of the coal-seam, and are chiefly brown-coloured, coarse-grained, and sometimes sandy. One of the localities where it is mined by benching—Sandy Creek Furnace—is about three-quarters of a mile S.E. of the works, and is situated on the level summit of a hill. Brown shale and soil have been thrown out to the depth of 5 or 10 feet. The ore is of the small nodular variety, and only tolerably good. The other place is 2 miles S. of the Furnace: this is likewise on the broad level summit of a hill. Above the ore are 5 feet of brown shale and clay, covered by soil. The ore consists of two varieties—the blue-clay ironstone, in flat nodules, from 18 to 24 inches by 12 broad, and about 4 inches thick; and the small nodular kind, consisting of brown and black crusts, with a nucleus. The former is fine-grained, blue, homogeneous in texture, compact and heavy, containing sometimes particles of white spar, which are dispersed throughout it. The hard ore of Rheno's Furnace is obtained about 2 miles from the Furnace on the creek: it is found on the top of a hill, as in the other localities, and in the same bed of brown shale; nor does the ore differ materially from the others. The shale is probably thicker here than further N., in the neighbourhood of Meadville and Sugar Creek Lake. The Sharon Coal is said to have been found beneath the conglomerate, in the hill on the S. side of Sandy Creek, near where the Franklin and Mercer Road crosses it. W. of Rheno's Furnace, on the Mercer Road, Mr J. Adams once opened a drift on the Tionesta Coal-seam.

About three-quarters of a mile E. of the county-line this bed is much better exposed: it is here 2 feet thick, and covered by black and brown shale, but has been opened half a mile farther S., 6 feet thick. At the latter place the dip has brought it down to a lower level. Its divisions read as follows: Shale; Coal, 9 inches; Clay, 3 inches; Coal, 5 feet, with some sulphuret of iron, but good.—(See Figs. 400 and 401.) Above it rises the massive outcrop of the Tionesta sandstone, half-way up the hills, capped by a small coal-bed (the Brookville Coal), opened, but unfit to work, a fourth of a mile farther W.

The lower Porter Coal-bed appears upon the Sandy Creek Hills. Above it is seen a bed of blue argillaceous limestone, similar to that already mentioned as underlying the Tionesta Coal.—(See Fig. 400.)

Henderson's Drift, in Mercer County, half a mile from the Venango line, is undoubtedly on the Tionesta Seam, and the high land between the heads of Little Sandy and Mill creeks likewise contains it. It has been worked near the source of the latter stream, N. of the Franklin and Mercer Road, where it rests upon and is covered by brown shale.—(See Fig. 401.)

In the neighbourhood of Sandy Lake the Tionesta Coal-bed is well developed. At the former locality there are about 5 feet of good coal, covered by brown shale, which contain a few thinly-scattered nodules of argillaceous ore. Beneath the coal is a yellow sandstone, sometimes argillaceous. Under this is a crushed coal-bed, 30 feet beneath the Tionesta Coal, and a continuation of the Upper Porter Bed. This is the most Eastern opening of the bed yet known; but it is not here workable.

Fifteen feet beneath the Upper Porter Coal is the blue argillaceous, fossiliferous limestone, 15 inches thick, containing chiefly Leptæna and elongated concretions of iron, from a fourth to half an inch in diameter, and from 3 to 6 inches long. Under the limestone is shale, which rests upon the representative of the great conglomerate.

The hill is capped by the Tionesta sandstone. About half a mile W. of Brown's Bank, and still on the S. of the lake, a drift was opened on the same bed. The shale which usually overlies the coal is here wanting, and the Tionesta sandstone rests immediately upon the coal. The bed measures in all 6 feet, the upper 12 inches being separated by 12 inches of clay from the 4 feet of good coal below: the floor is shale. From the coal-bed down to the lake, a vertical depth of 100 feet, no exposures are seen.

On the N. side of the lake the same seam has been opened; the associated rocks are the same.

On Cool Spring Creek the limestone has been found sufficiently thick to be worked for the lime-kiln. It is bluish or grey, and earthy in its appearance.

The Lower Porter Coal-bed, 5 inches thick, is seen immediately underlying the limestone, which is exposed at Crill's Mill, 3 miles E. of Mercer Town, where it is 3 feet thick, slaty, earthy, and of a dark-blue colour, containing Producta and other fossils in abundance. Here, instead of coal, we see from 2 to 3 feet of black bituminous shale beneath it, representing the Lower Porter Bed.

At Crill's Mill, 3 miles E. of Mercer (see Fig. 402), we have the following section :—

Brown Shale ; Coal, 4 feet (Conolly's) ; Sandstone and Shale. Coal, small and crushed (Upper Porter Bed) ; Sandstone ; Shale. Limestone, 3 feet. Black bituminous Shale, 2 or 3 feet (Lower Porter Coal) ; Brown Shale ; White flaggy Sandstone.

The Conolly opening on the Tionesta Coal is near the top of the hill ; the coal is good, but wrought to disadvantage. Dip a little to the E. of S., but occasionally locally reversed. The drifts should always run in N.W.

There is a higher point of ground, half-way between Conolly's and Mercer, where this seam might be opened on the S.E. side of the hill. The spot where it outcrops is marked on the N. and W. side by the issue of several springs of water. It is a little higher than the level of Conolly's Drift.

CHAPTER XIV.

NORTH-WESTERN BORDER OF THE SIXTH BASIN—(*Continued*).
MERCER AND THE BEAVER RIVER.

THE hill upon which the town of Mercer stands exposes sandstone and shales, but neither the limestone nor coal-beds of the Tionesta group have been discovered in it, although within 1 mile to the W. they are extensively wrought. One faint coal-smut, the outcrop of a small bed struck in sinking a well in the outskirts of the town, appears upon the hill-side near the summit, but cannot be identified. It may possibly prove to be the Tionesta Bed, greatly thinned away ; a vein made probably by the appearance of the limestone upon the turnpike, 1 mile S. of the town, at a low level. It is there from 12 to 15 inches thick, and has the Lower Porter Bed (from 12 to 20 inches thick) below it.—(See Fig. 403.)

On the hill some distance higher up the run, we see fragments from the Tionesta sandstone bed. Farther down the turnpike on the Mercer side of the Toll-gate the same limestone may be traced in the meadows. This shows a decided dip to the S.E.

Wright's Coal-bank is the first W. of the town, and that from which the chief supply of fuel is obtained. The level of the opening is a little lower than that of the Court-house. From 20 to 25 feet of black and brown shales overlie the coal, the black shale containing some minute fossil-shells. The coal is 5 feet thick, light, compact, and good. At Porter's Drift the bed is 6 feet thick, but subdivided by a band of black slate from 6 to 12 inches thick. The coal is not so pure as elsewhere.

At Davis's opening the bed yields 2½ feet of good sound coal. On the same tract, 63 feet below the coal-level, we see the Mercer limestone. It is not well exposed, but the pieces lying near are of a dark colour, with abundance of minute fossils. The strata between it and the Mercer Coal, a fourth of a mile farther W., are, as we descend the hill to the Lackawanna (see Fig. 403), as follows :—

Soil ; Brown Shale, 5 feet ; Black Shale and fossil Shells, 17 feet ; Fire-clay, 1 foot. *Tionesta Coal*, 5 to 6 feet ; Fire-clay, 2 feet ; Black and brown Shale, with argillaceous Sandstone, 30 feet ; Black Shale, 4 feet ; Sandstone, with vegetable remains, 1 foot ; Black bituminous Shale, 2 feet. *Upper Porter Coal*, 1 foot ; Fire-clay, 2 feet ; Black and brown Shale and Sandstone, 6 feet. *Middle Porter Coal*, 1½ feet ; Sandstone, 6 feet ; Bluish and brown Shale, with iron ore, 14 feet. *Mercer Limestone*, 1½ feet ; *Lower Porter Coal*, 1 foot ; Blue Shale, with iron ore.

We have here a striking contrast between the 50 feet thickness of intervening shales and sandstones and

the coal-bed of the Tionesta region. Yet when the series shall have been thoroughly examined, the same variable alternations of carbonaceous and non-carbonaceous materials may be developed there as here.

A mile and a quarter farther W., a similar section (Fig. 404) was obtained as follows :—

Tionesta Sandstone, 50 feet ; Black Shale or Clay, 1 foot. *Tionesta Coal*, 4 feet (shale in the middle) ; Fire-clay, and blank interval, 46 feet. Blue Shale, 11 feet. *Coal*, 9 inches ; Brown Shale, 2 feet. *Limestone*, 18 inches. *Lower Porter Coal*, 1 foot ; Bituminous Shale, 2½ feet. *Coal*, 1½ feet ; Shale, 10½ feet. Brown Sandstone, 63 feet, which is the representative of the Seral conglomerate.

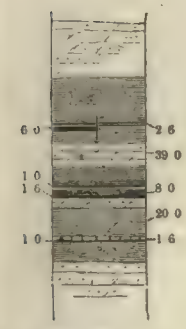


FIG. 403.—Mercertown.

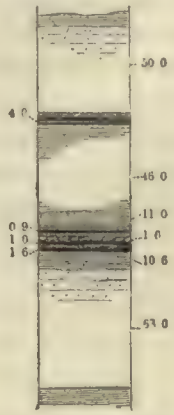


FIG. 404.—Jenkin's Mill.

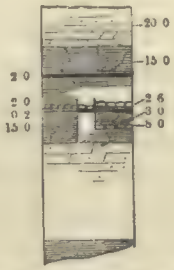


FIG. 405.—Mr Porter's.

FIG. 406.—Neshannock Creek.

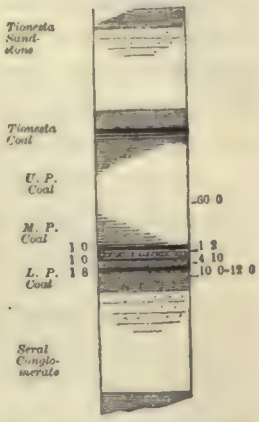


FIG. 407.—Two miles W. of Mercer.

The Lower Porter Bed is wrought 3 feet thick on Mr Porter's farm to the right of the Sharon Road. The limestone lies upon it, and, including a few inches of calcareous shale, is 4 feet thick. But both coal and limestone change their respective thicknesses incessantly. Thus the following section (see Fig. 405) was made within a few hundred feet of the last :—

Brown slaty Sandstone, 20 feet ; Shale, 15 feet. *Middle Porter Coal*, 2 feet ; Slaty argillaceous Sandstone, passing downwards into shale, 12 feet. *Mercer Limestone*, 2 feet. Shale, with a 2-inch-thick seam of coal, 15 feet.

Again, at Porter's Bank, the strata appear thus :—

Soil and diluvium, 15 to 20 feet ; Rotten Calcareous shaly Rock, 3 feet. *Limestone*, 2½ feet. *Coal*, 3 feet ; Shale, 8 feet.

Here the coal is light and good. Beneath the 8 feet of shale appears an unknown limestone. The shale, both above and below the limestone and coal, contains a considerable quantity of argillaceous iron-ore in small scattered nodules. This is the case on the Sharon Road, where the lower shale-bed is usually a bluish or brown rock, containing some non-continuous bands of argillaceous sandstone. This bed is seen at Jenkin's Mill, 2 miles below Mercer, near the water-level of the Neshannock Creek, where the following section (see Fig. 406) was compiled :—

Shale, containing nodular ore. *Coal*, 15 inches ; Light Shale, with ore ; Black Shale, with ore, 2 feet ; Shale, 3 feet, with five layers of nodular ore ; Sandstone, with vegetable remains, extending 6 feet to water-level.

This is the Seral conglomerate. The ore has been wrought at Springfield Furnace, where the Tionesta sandstone is finely exposed—sometimes as a conglomerate, with pebbles as large as a common pea.

About 2 miles W. of Mercer, on the Micheltree Road, there lies, between the Tionesta Coal-bed and the Tionesta Sandstone, but an inconsiderable thickness of shale, the sandstone being about 50 feet thick.—(See Fig. 407.) The coal-bed at Lafferty's and Adam's is divided by a bed of black slate, from 12 to 15 inches thick, as at Porter's, with this difference, that at the latter drift the band of coal beneath the slate is thicker than that above, while, at the former places, the greatest thickness belongs to the upper band. The slate-band gradually approaches the bottom of the coal-bed as we proceed W., until it at length entirely shuts out the lower coal-member, and permits the upper to become the whole bed at the Shenango Creek.

The limestone in this neighbourhood is to be seen about 60 feet below the coal, and may be well studied

on Law's farm. Two feet above it is a small bed of coal, less than a foot in thickness, upon which rests bluish shale. Beneath the limestone we have,—

Coal, 1 foot; Black Bituminous Shale, 1½ feet; Brown Shale, 14 inches; Black Bituminous Shale, 7 inches; *Coal*, 20 inches.

Twelve or fourteen feet beneath the lowest coal appears the top of the Seral conglomerate. These mines may be said to mark the last outcrop of the beds of the Tionesta Group toward the N.W.

Seven miles W. of Mercer, on the Sharon Road, the top of a high ridge receives the Tionesta Coal-bed within 20 feet of the summit, while below it appear fragments of the limestone stratum. The coal is evidently a workable bed at this its last appearance. On Hog-back Run, 4 miles or more S. of Sharon, and about 2 miles from its entrance into the Shenango, on its E. bank, the Mercer Limestone and its underlying coal again appear. The limestone lies in blocks in the stream, and the shale beneath it contains a considerable quantity of blue nodular iron-ore. The limestone is seen again farther down the Shenango, near Paoli, generally sinking to a lower level.

In the neighbourhood of Newcastle, three tolerably complete sections were obtained (see Figs. 408, 409, 410.) The following is from a stream emptying into the Neshannock, 2 miles above the town, on the W. side of the Creek (see Fig. 408):—

Tionesta Sandstone, 50 feet; Iron Ore, 6 inches. *Limestone* and Chert, 2 feet; Interval, 8 feet; Blue Slate, 2 feet; Clay, 6 inches; Black Shale, 1½ feet; Light-coloured Shale, 3½ feet. Light-blue Shale, with bands of sandstone, 4 or more feet. Interval, 6½ feet. *Mercer Limestone*, 1½ feet. Light-coloured Shale, with sandy seams, 5 feet. *Coal*, 6 to 8 inches, *bituminous*. Slate, 2 feet; Bluish crumbly Shale, 2½ feet. Greyish rotten Sandstone, with vegetable impressions, 1½ feet; Sandstone, flaggy, 8 feet; Brown Shale, 5 to 6 feet; Bituminous Shale, 1½ feet; Bluish or grey slaty Sandstone, with much vegetable matter, 5 feet; Sandstone, 70 or more feet (Seral conglomerate).

We here see the two great sandstones separated again by an interval of only 61 feet. The coals above the Mercer Limestone are gone, or represented by bituminous shale; another limestone, accompanied by black flint and a hard silicious iron-ore, is now first noticed as occurring at the base of the Tionesta Sandstone. There is but one interval, of 8 feet, where the Tionesta Coal could conceal itself, and this occurs in the proper position; but it is more probably represented by 1½ feet of bituminous slate.

The following section, made at a point about a mile N.W. of Newcastle, on a little run emptying into the Shenango (see Fig. 409), shows that conformity of one section to another, where obtained at different localities, though of the same series of beds, is not to be expected in the lower portion of the great Coal-formation:—

Tionesta Sandstone, 50 feet. *Coal and bituminous Shale*, 3 inches; Brown and blue Shale, 1 to 6 feet. *Limestone*, cherty and ferruginous, 2 feet. *Coal*, 12 inches; Light-coloured Shale, blue at the top, 6 to 8 feet; Argillaceous Sandstone, 2 feet; Light-coloured Shale, 12 to 13 feet. *Bituminous Shale and Coal*, 4 feet; Blue sandy Shale, 6 feet; Flaggy Sandstone (S. C.), argillaceous at top, 75 feet or more.

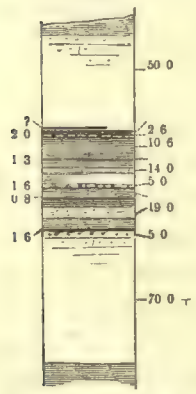


Fig. 408.—Two miles above Newcastle.

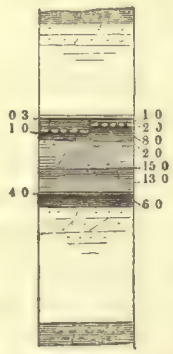


Fig. 409.—One mile N.W. of Newcastle.

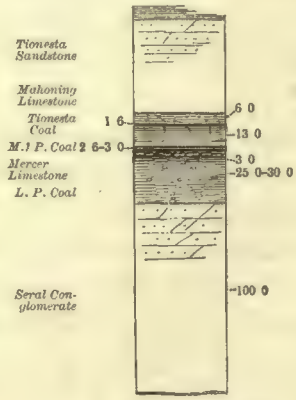


Fig. 410.—Two miles below Newcastle.

Beneath the main Seral conglomerate appears a bed of brown shale, containing ore well exposed, at the W. end of the bridge over the Shenango. This ore, with that described repeatedly in the last chapter as accompanying the Sharon Coals, may very properly be considered the representative of the upper red-shale ore, assuming still greater importance in connection with a lower coal-series on the borders of Virginia, and along the line of Chestnut Ridge.

Sections 408 and 409 are less than 3 miles asunder, although displaying so great a diversity in the series of the beds. Compare the lower coal, &c., in the vertical columns, 403, 404, and 407, with those of 408 and 409. In section 409 the lower limestone may have been overlooked.

The upper limestone will be called hereafter the Mahoning limestone, because well developed along that river: it is well seen in the runs that empty into the Mahoning, some 5 or 6 miles above its junction with the Shenango, where the series of strata does not differ materially from that given in the last section. W. of the State line the iron ore which accompanies this limestone has been mined.

At the junction of the Mahoning and Shenango creeks, the Seral conglomerate sandstone is well seen, and also in the immediate vicinity of Newcastle. In some portions it is highly argillaceous, but above the middle of the bed it is thick-bedded, soft, and but little mixed with argillaceous bands. Its whole thickness is about 100 feet. The Tionesta measures average 60 feet, and the upper or Tionesta sandstone, which is more solid in this locality than the Seral conglomerate, may be estimated at about the same thickness. The distance of the upper surface of the Tionesta sandstone above the Neshannock, at Newcastle, was found by levelling to be 240 feet: the lowest 20 feet consist of shales, seen at the bridge at the W. end of the town.

At Big Run, 2 miles below Newcastle, the following imperfect section (see Fig. 410) was compiled:—

Tionesta Sandstone; Blue Shale with iron ore, 6 feet. *Coal*, 1½ feet; Blue Shale, 8 feet, very argillaceous; Rotten Sandstone, 2½ feet; Blue and brown Shale, with 2½ feet of sandstone at the bottom. *Bituminous Shale*, from 2½ to 3 feet. *Mercer Limestone;* Shale, 3 feet, blue; Shale, with concretions of iron ore; Interval, 25 to 30 feet.

Seral Conglomerate Sandstone.—Down the Beaver River the rocks are not well exposed. The Seral conglomerate sandstone passes under the water-level above the mouth of the Conequenessing Creek. At Wompum Hill, a bed, supposed to be the Mahoning Limestone, is seen 42 feet above the Beaver River. At the mouth of Conequenessing the Tionesta Sandstone is seen on the hill, where large blocks are lying about the surface, and on Slippery Rock Creek, from its mouth up to the bridge at the Mercer Turnpike: there it passes under the water-level. From the mouth of the Conequenessing down toward Brighton, the Tionesta Sandstone may be seen on both sides of the Beaver River, declining gradually to a lower level, until at length it sinks into the bed of the river, and forms the upper fall above Old Brighton.

On the Eastern side of the Beaver, a little above the falls, some of its beds are divided diagonally by curiously undulating lines, which are probably lines of deposition; these belong only to certain beds, and rarely pass from one bed to another. Generally speaking, the stratum so disposed is separated from the next similar stratum by one or more thin layers of sandstone, destitute of these transverse lines, all of which have an E.N.E. and W.N.W. strike, dipping nearly W.N.W.

CHAPTER XV.

SIXTH BASIN IN JEFFERSON AND CLARION COUNTIES; COAL-BEDS ABOVE THE TIONESTA SANDSTONE.

Some of the hills between the Tionesta and Racoon creeks seem high enough to receive the first or second beds above the Tionesta Sandstone, although in the wilderness condition of the country this could not be experimentally proved. It is certain that these beds overspread much of the region between Racoon Creek and the Clarion, some of the higher hills containing rocks even as high as the Ferriferous Limestone. The most northern locality in the basin in which this rock has been discovered, is near the Forest County boundary, and upon the central line of the basin, about 5 miles N.W. of the fifth axis. Fragments of it lie about the soil, accompanied by pieces of iron ore and lumps of chert.

The Clarion Coal-Bed is seen beneath it 30 feet; below which, at an equal distance, is the place for the Brookville Coal, not here discovered; 10 feet more bring us down to the top stratum of the Tionesta Sandstone. —(See Figs. 411 and 412.)

The Clarion Coal-bed at its outcrop on Leach's Farm, in Farmington Township, is 4½ feet thick, and good; roof

brown shale, 4 feet. Again, 3½ miles to the S.E. it is 4 feet thick, good, but slightly pyritous. Again, 1 mile to the E. it seems to be but 2½ feet thick; quality good: the roof is shale, 25 feet thick.

The Brookville Coal is here traced with difficulty. It is seen 2 miles N.W. of Leach's, from 18 to 20 inches thick; 30 or 40 feet of brown shale and argillaceous sandstone lie between it and the Clarion Coal, and a few feet of the same rock below it, to the Tionesta Sandstone.

The Clarion Coal and Ferriferous Limestone occur, at Copp's Settlement; 1½ miles N. of the Settlement; at Henley's, 1 mile W.; at the Meadows, at the head of Six-mile Run, 5 miles W. of the Settlement; and on the Eastern limit of the basin E. of the Jefferson County line, and a little back from the Clarion River, where exposures are rare and imperfect. The Tionesta Sandstone arches over the fifth axis as a surface rock, occupying even the highest grounds, along a strip of country 4 or 5 miles wide.

In the bed of Mill Creek and all the streams which empty into the Clarion on either side, but more especially those which, having their source in the Fifth Basin, cross the axis and flow into it from the S.E., the massive rocks of the Seral conglomerate are exposed, and the underlying Vespertine and Vergent series are seen in the deep gorges of Spring Creek and the Clarion River, and in Laurel Run, and above the mouth of Mill Creek.

Bog Iron-Ore.—The base of the Seral conglomerate is the position at which we find the chief bog-ore deposits of the Clarion.

Several of these deposits occur in the vicinity, and on the W. side of the Clarion in Farmington Township, and are worthy of notice. They are about a mile below the mouth of Laurel Run; and upon the opposite side of the river, between two small streams, from 5 to 10 acres are covered with this ore. The deposit at Allsbach's is said to be three-fourths of a mile long. Two miles N. of this there is another extensive deposit of the same iron ore. On the opposite side of the Clarion, up Laurel Run, there are several other deposits more or less extensive.

On some of the higher hills in the neighbourhood of the village of Corsica, upon the Jefferson County line, where the Brookville Turnpike crosses it, the Freeport Limestone has been found within a few feet of the surface. One of these hills is near the turnpike, a mile E. of the town. The Ferriferous Limestone is commonly found at the base of the hills.

Few attempts were made to trace the exact outcrops, or to refer the different coal-drifts to their respective seams in the country bounding the Clarion above Mill Creek. The hills, which are sufficiently high to reach the base of the Ferriferous Limestone, everywhere contain two coals, the Clarion and Brookville beds. Many of the hills which are not high enough for the former, contain the latter; and both of them, together with the superposed limestone, crop out in a line running nearly parallel to the axis, from the Clarion about 2 miles above the Jefferson County line to Mill Creek, 3 or 3½ miles back from its mouth.

The Ferriferous Limestone at its outcrop is only seen in a few rounded isolated knobs, which are easily recognised, and have a somewhat regular range corresponding to that of the axis. It is accompanied by its characteristic chert and iron ore.

The limestone and underlying coals are well seen 5 miles below the mouth of Laurel Run, on Paint Creek, and at the top of another high knoll, 1 mile below the mouth of Laurel Run in Farmington Township.

The Buhrstone or Chert at these localities is abundant, compact in texture, grey externally, light blue when fractured, and covers the surface with fragments from 3 to 12 inches in diameter. The Brookville Coal is seen below it.

The same beds occur on many knolls between Laurel Run and Strattonville. The chief obstacle to an easy discovery of it arises from the fact that the limestone, when thin, is easily decomposed; it is not apt to form a bench or terrace along the slopes.

As the basin deepens S.W., this system of beds gradually descends to the base of the isolated hills, and finally overspreads the whole country. Many of the hills in Paint Creek Township, and about the heads of Deer Paint Creek, embrace an ore capped by the limestone, and at a lower level show the Clarion and Brookville coal-beds.

At *Lucinda Furnace,* on the high ridges on each side of Deer Creek, the limestone is seen capping the hill,

accompanied by the chert and iron ore. At the ore-bank about 1½ miles S.E. of the Furnace, and near the level top of the hill, the stratification is as follows:—

Clay, covered with soil, from 4 to 5 feet. *Iron Ore*, from 6 to 24 inches. Chert; limestone. (See Fig. 412.)

The ore is variable in its characters, being sometimes a solid, hard, blue fossiliferous stratum, looking like limestone, while at others it consists of crusts or shells, containing cavities and concentric nodules. These nodules are sometimes 9 inches in diameter, and contain a yellowish nucleus, surrounded by a hard black crust a fourth of an inch thick. The chief part of the ore, however, does not consist of regularly-formed nodules, but of small crusts, which look like fragments of larger masses, and break into small pieces. These frequently contain cavities filled with an unctuous dark-coloured fluid, which escapes when the shell is broken. The inside of these crusts is usually smooth, sometimes of a beautiful glossy black colour, or covered with minute yellow, purple, or violet-coloured crystals: this is most common nearest to the chert. In the upper part of the ore stratum, the shells are much mixed with yellow clay, which itself contains much peroxide of iron. Between the limestone and the ore lies the chert, which passes sometimes into one, sometimes into the other, in which latter case it is often highly coloured by the peroxide of iron. The limestone is known to exist at places several miles to the N. and N.W.

On the hill opposite the Furnace a coal-bed has been opened, from 4 to 5 feet thick, of good quality, and 40 feet below the limestone, at the summit. The same bed is wrought 1 mile S. of this. It is a question whether this is the Clarion or the Brookville Coal.—(Compare Figs. 411, 412, and 413.)

FIG. 411.—Racoon Creek, Clarion River.

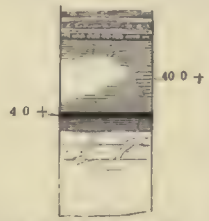


FIG. 412.—Lucinda Furnace.

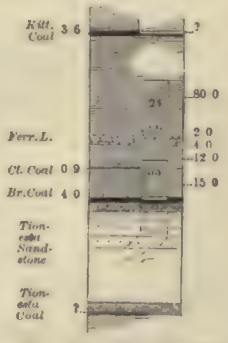


FIG. 413.—Strattonville (three Sections).

Bog Ores.—On land belonging to Lucinda Furnace on Paint Creek, two bogs have formed from ore issuing from beneath the Seral conglomerate, each covering half an acre of ground, and from 2 to 8 feet deep.

Four miles N. or W. of Lucinda Furnace, the Ferriferous Limestone and its ore have been dug or benched away over an area of more than an acre, upon the summit of a very high hill. Over them lie blue and brown shales 4 feet thick. The ore is chiefly shell-ore; the limestone dark-blue and heavy.

In the deep gorges of the Clarion River, and most of the larger streams that empty into it, the massive sandstone which represents the Seral conglomerate may be seen resting immediately upon a light olive and greenish-coloured shale, more or less arenaceous, and breaking into wedge-shaped fragments. These are the Sharon Measures. They contain two bands of sandy iron-ore easily wrought, and free from sulphur. They may be studied at the mouth of Paint Creek, one-third of a mile above the Clarion River Bridge.

Issuing from the base of the conglomerate, bog-ore is found E. of Shippensville, also in Elk Township, and in Beaver Township. A bog, one-third of a mile S.E. of the Lucinda Furnace, covers an acre of ground, and averages 3 feet in depth; while one of equal depth, a mile N. of the Furnace, covers from 2 to 3 acres.

At the county-seat of Clarion the Clarion Coal-bed lies 40 or 45 feet beneath the Court-house. It has been opened at its outcrop upon the face of the hill overlooking the Clarion River. The bed is 3 feet thick, but yields coal too impure for common use, because of the sulphur and pyrites which it contains. Attempts were made by Judge Myers to find the Brookville Bed, but they were not attended with success. The latter coal is said to have been penetrated by a well sunk many years ago on the high ground near the Court-house, at a distance of 30 or 40 feet below the upper coal. E. of the town the lower coal was bored into several feet; and it is highly probable that the same bed may be found of workable size at Clarion, after it has been fairly entered beneath the hill.

At Strattonville the series of rocks, as exhibited in Fig. 413, is the same that we have been consider-

ing. The fifth axis crosses the Brookville Turnpike about 3 miles W. of the Jefferson County line, and brings up the Tionesta Sandstone, dipping each way at an angle never exceeding two degrees. At Strattonville the upper beds of the Tionesta Sandstone are seen in the hollows crossed by the turnpike, while the trough of the Clarion River cuts down into the Vespertine sandstones.

Here the Brookville Coal is the principal bed, whereas to the W. and S.W. the Clarion Bed is the largest. The former is 4 feet thick (Fig. 413.) At Strattonville, 7 miles W. of Brookville, it is opened almost on the anticlinal axis, dipping only half a degree S.E., where it is 3 feet thick. At the bottom of a well, sunk through 30 feet of black and blue slates, there are large quantities of nodules of very fine carbonate of iron enclosed in shale. No limestone could be seen. These strata are above the Brookville Coal. Thirty feet above the mouth of the well was a clearly-defined coal-bench in the hill-side, probably the Kittanning Coal.

The ore said to be passed through 6 feet beneath the Ferriferous Limestone in Lowrie's Well at Strattonville, corresponds in position to that found beneath the same stratum at the Great Western Furnace on the Alleghany River, and elsewhere farther W. The Buhrstone ore and Ferriferous Limestone appear on the slopes of the hill around Wilson's opening in the Brookville Coal-bed, which dips 2° N.W., and is 4 feet thick. The very white and massive sandstone, seen for a thickness of 50 feet below the coal, is the Tionesta Sandstone: under it there are evidences of the presence of the Tionesta Coal-bed.

The diminution in the whole thickness of rocks between the Ferriferous Limestone and the Tionesta Sandstone in this neighbourhood, as well as the thinning-out of the Clarion Coal-bed, are worthy of remark. The section from Lowrie's Well is as follows—(see Fig. 413):—

Slate, 24 feet. Chert or Buhrstone, 2 feet. *Limestone*, 4 feet. Shale, with iron ore, 35 feet. *Coal* (*Brookville*,) 3 feet; Shale ore; Tionesta sandstone.

The hill-sides W. of Strattonville, sinking down to the Clarion water-level about 300 feet, give the following section:—

Kittanning Coal, thin (here first observed going S.W.) Interval, 80 feet. Limestone, 4 feet. Interval, 12 or 15 feet; *Clarion Coal*, 9 inches. Interval, from 15 to 20 feet.

Western Side of the Clarion.—The Tionesta Sandstone is the prominent cliff-rock in all the valleys that enter that of the Clarion upon its right bank.

At the Deal Bank, 2 miles S. of Shippensville, the Ferriferous Limestone-ore has been extensively wrought upon a flat-topped hill. The ore was from 6 to 4 feet thick, being exceedingly variable even in short distances. Over it lie about 6 feet of argillaceous slaty sandstone and shale bedded in a very irregular manner, and divided in several places by joints. Above this lies a brown shale. The ore is accompanied by chert, which occurs in pieces from 10 to 4 inches square, and appears to be most abundant in the upper part of the ore-bed. The limestone is separated from the base of the ore-bed by a greenish slaty sandstone several feet in thickness.

The Clarion Coal-Bed has been opened in this neighbourhood. It cannot be much more than 15 feet below the limestone. It is from 2½ to 3 feet thick. The *Brookville Coal* is upwards of 20 feet lower down, and is an inconsiderable bed. Both these coals have likewise been opened on the Deer Creek Hills, where they are 40 feet apart; the upper one 2 feet, and the lower one from 2 to 4 feet thick.

The Tionesta Coal is here seen, beneath the Tionesta Sandstone, 14 inches thick.—(See Fig. 413.)

The Kittanning Coal is supposed to exist in the high knobs 4 miles upon the Emlenton Road, S.W. of Berlin's Old Tavern, 4½ miles W. of Shippensville, with remnants of the arenaceous slate-group above it, and with 80 feet of strata below it to the Ferriferous Limestone. Proceeding into Elk Creek and Rockland townships, we see the Tionesta Sandstone still more abundantly in the hollows and ravines; and the Seral conglomerate is in the deep trench of Six-mile Run. A few of the most elevated knobs are capped by the limestone, and contain the underlying coal. The former is seen cropping out 2 miles E. of Myerstown on the turnpike at Six-mile Run, and also on another hill 2 miles toward the S.S.E. We find its line of outcrop marked by a series of small rounded hills, which pass nearly through the middle of Rockland Township. The outcrop of the Clarion Coal-bed conforms to that of the limestones above it. It enters only a few straggling knobs beyond this, towards the

N.W. That of the Brookville Coal is perhaps 2 miles still farther in the same direction. This bed is found only occasionally upon the Alleghany River above the mouth of Scull's Run—the upper beds not at all; but they all appear upon the hills where these become higher, half a mile or more back from the river.

Two miles below the mouth of Scull's Run the following section (see Fig. 416) was obtained :—

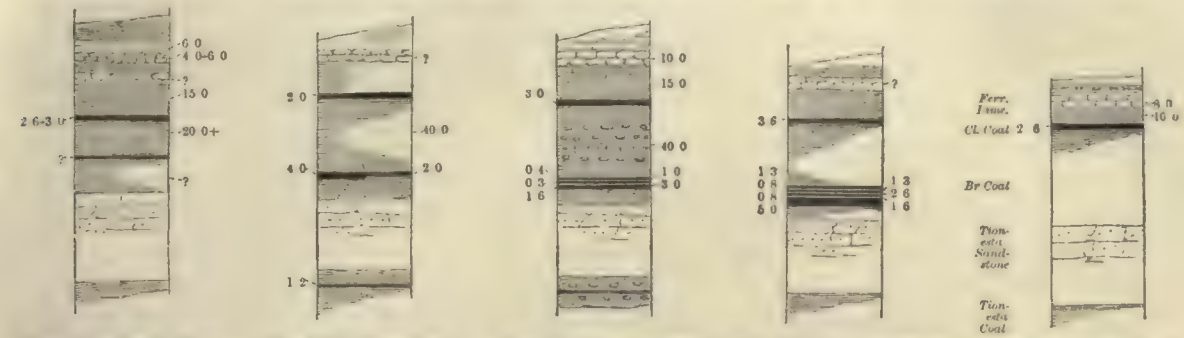


Fig. 414.—Deal's Bank, Shippensville. Fig. 415.—Deer Creek. Fig. 416.—Scull's Run. Fig. 417.—Rocklandtown. Fig. 418.—Alsboch's.

Sandstone, 8 feet exposed. *Ferriferous Limestone*, 10 feet. Interval, 15 to 20 feet. *Clarion Coal*, 3 feet; Brown Shale with iron ore, 40 feet. Brookville Coal, 4 inches; Black Slate, 1 foot; Coal, 3 inches; Black Slate, 3 feet; Coal, 18 inches; Black Slate; Slaty (Tionesta) Sandstone.

The four beds of nodular iron-ore in the 40-feet interval are in the descending order, according to the names by which they are locally known, as follows :—

1. "Roll Ore," in masses from 2 to 3 feet long, and from 8 to 12 inches thick, coarse-grained. 2. "Pig Ore," in cyclindrical nodules, from 6 inches to 2 feet in length. 3. Small nodular band "Flag Ore," in flags from 6 to 20 inches in breadth, scaling off in conchoidal crusts upon exposure.

The presence of the *Tionesta Coal* is indicated along the river-hills by its outcrop smut; and the ore of this series is mined at Campbell's, and at the same height on the W. side of the river. The shale above and below the coal contains more or less ore.

Bog Iron Ore occurs on the lands of Messrs Rockwell & Co. in four places,—J. F. Retter; Boyne, J. Brown; Brigham estate, three places; Rockwell & Co., Pine Creek; Nichol's, Scull's Run; Smuller, half a mile E. of the furnace; and Thompson. Mr Smuller's bog-ore covers 10 acres, from 1 to 4 feet deep.

In *Richland Township* the bog-ore, issuing from the base of the Seral conglomerate, occurs on the lands of Messrs J. Shaeffer, J. Platt, Wm. Carn, and Wm. Knobs.

In the knolls upon Crawford's Farm the limestone is seen. Beneath it is the *Clarion Coal-bed*, 3½ feet thick. The *Brookville Bed*, though not exposed here, is seen 3 miles S. in a rather deep hollow, the alternations of shale and coal being as follows :—

Soil, 2 feet; *Coal*, 15 inches; Soft Black Shale, 15 inches; *Coal*, 8 inches; Shale, 30 inches; *Coal*, 8 inches; Hard Shale, 18 inches; *Coal*, 5 feet, which last has been opened by Mr Purviance, a mile distant.—(See Fig. 417.)

The limestone spreads itself very generally through the S. and S.E. parts of this township, and is accompanied in some places by the iron ore and buhrstone. The latter is found at J. Shaeffer's, Peter Bouch's, J. Alsboch's, &c. Five miles from Emlenton, and about 10 miles from Shippensville, all the strata in connection with the limestone are well exposed, thus :—

Soil, 1 foot; Clay, &c., 5 to 8 feet. *Ore*, from 10 to 18 inches. *Limestone*, with *Buhrstone*, 8 feet. Shale, brown, friable, 10 feet. *Clarion Coal*, 2½ feet (see Fig. 411.) The buhrstone is about 9 inches in thickness.

The Kittanning Coal-bed, 18 inches thick, is seen some distance above the limestone, near Foxburg, in the S. part of Richland Township, and on the high-land to the E. of Turkey Run, in Beaver Creek Township, and occasionally in the high land S. of the Clarion, and between the Alleghany River and Cherry Run. It is

but a small bed, covered by shales, and these by the Freeport Sandstone (seen in the hills about Cherry Run and Licking Creek), and lies about 50 feet above the Ferriferous Limestone. This latter, having sunk down to near the base of the hills, is found abundantly in the ravines.

Both on the Alleghany and on the Clarion River in the neighbourhood of Callensburg, it is abundant, and only in the axis of the synclinal trough, about the head of Cherry Run, does it sink entirely below the level of the country. But at Curlsville, in the valley of Licking Creek, half-way between the Clarion and the mouth of Red Bank Creek, which is also in the middle portion of the trough, the limestone, with the buhrstone very finely developed, is seen in the low land.

On ascending the high hills three-fourths of a mile S.W. of Curlsville, on the Waterson's Ferry Road, we meet with the most N.E. localities of the *Lower Freeport Coal* (which belongs to the series next above), resting upon the Freeport Sandstone, and occupying the centre of the basin. It is opened both on the N. and S. sides of the road, the strata at the two places having dips in opposite directions, both towards the road which here runs in the middle line of the basin.

On the hill N.W. of the town four beds of coal have been opened: first, high on the hill, the Lower Freeport Bed, approaching its final outcrop; next, the Kittanning Coal, underlaid at some distance by the Ferriferous Limestone, which forms a conspicuous bench; and immediately beneath this a thin coal-seam, and at the base of the hill the Clarion Coal-bed well developed. These beds are of workable dimensions.

Its N. line of outcrop extends in a pretty regular line to a point on the Alleghany River, two and a half miles below the mouth of Beaver Creek, while its S. line of outcrop passes about three-fourths of a mile S. of Roseburg towards the mouth of Red Bank Creek. The area, therefore, occupied by this seam on the E. side of the Alleghany is not great, its greatest width being little more than six and a half miles. The Lower Freeport Coal-bed has been opened in several places, and yields from 2 to 4 feet of tolerably good coal.

The *Upper Freeport Coal*, supported by the Freeport Limestone, and at an elevation in the series of 40 feet above the Lower Freeport Coal, is first met with on a high knob to the N. of the Roseburg Road, half a mile from Curlsville. The *limestone*, as seen in fragments, is a light-blue compact rock, weathering yellow, because containing some peroxide of iron. The coal lies a few feet above it. One outcrop runs in a North-bending curve to the Alleghany, two and a half miles above the mouth of Catfish Creek; the other passes half a mile N. of the Roseburg Road to the Waterson's Ferry Road, three and a half miles from the river, where a high hill, over which the road passes, contains coal and limestone, and skirts the river opposite Dennistoun's Run.

The Upper Freeport Bed yields from 3 to 4½ feet of good coal. The Ferriferous Limestone usually measures 4 feet. It yields a good lime, but is little used. It rests on 15 or 20 feet of arenaceous shale, containing near the bottom from 8 to 14 inches of nodular iron-ore in a single band, easy to smelt, and more profitable to work than many richer but harder ores. It is opened on the W. side of the river.

The River-hill Slopes at the centre of the basin are from 400 to 500 feet in height.

On its S.E. outcrop, in the Sixth Basin, the Kittanning Coal-bed becomes of available thickness only on approaching the Alleghany River, in the neighbourhood of Lawrenceburg and Sugar Creek, around Curlsville and Roseburg. In Madison Township, as opened by Messrs J. Weaver and P. Kratzer, it is 3½ feet thick. Here the Ferriferous Limestone and its ore occur, and again at the mouth of the Red Bank, and it is opened on the anticlinal axis. The lower coal-beds appear in the ravines, entering the Red Bank near its mouth.

CHAPTER XVI.

SIXTH BASIN; SOUTH-EAST-DIPPING CLARION GROUP; REGION WEST OF THE ALLEGHANY RIVER.

THE country to be described lies between a line drawn from the mouth of the Scrubgrass Creek on the Alleghany, through the S.W. corner of Sandy Lake Township, Mercer County, to the forks of the Mahoning

River at Newcastle, and another line drawn from the centre of Parker Township, Butler County, to the Beaver River above the mouth of the Conequenessing Creek.

The Brookville Coal, outcropping along the former of these boundaries, is poorly represented on this side of the river, in the neighbourhood of Scrubgrass Creek (see Fig. 419). It is usually about 18 inches thick, and separated from the Tionesta Sandstone by from 1 to 10 feet of brown shales. Above it is shale, usually brown, from 30 to 40 feet thick, which is the chief repository of the nodular iron-ore found in the Northern townships of Butler County, and the townships of Scrubgrass and Irvin in Venango County, if we except that found beneath the Tionesta Sandstone.

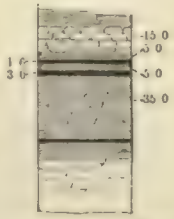


FIG. 419.—Scrubgrass Creek.

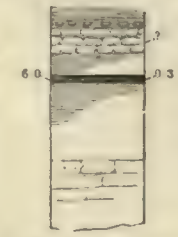


FIG. 420.—Mercer, Sandy Lake.

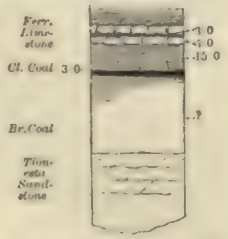


FIG. 421.—Sandy Lake.

The *Clarion Coal-bed* rests upon this shale, and is from 10 to 20 feet below the Ferriferous Limestone. These two seams of coal and the limestone outcrop very closely to each other, in a line passing directly E. and W. from the head of the run that empties into Scrubgrass Creek, one-fourth of a mile above its confluence with the Alleghany, to the S.W. corner of Sandy Lake Township, and the adjoining corner of Springfield Township, about a mile to the S.W. of the former. Thus far the outcrop of the next underlying coal accompanies that of the limestone very closely; but the Brookville Bed, though it probably exists, was not met with in the neighbourhood of the latter, unless perhaps at Brackenridge's and at Ossick's Mill; but these openings are supposed to be upon the *Clarion* Bed. Ossick's Bank is a few hundred feet to the N. of the Franklin and Mercer Road, and is not now open. The bed is said to be thin. A short distance farther down the creek, the upper layers of the Tionesta Sandstone are seen; it is quarried 2½ miles S. of the mill.

The whole of this line of outcrop is marked by a number of small rounded knolls, some of which are capped by the limestone bed *in situ;* others afford merely a few fragments under the ploughshare upon their summits. In the neighbourhood of Venango Furnace, and in the hills about Scrubgrass Creek, we find, in the shale embraced between the Tionesta Sandstone and the Seral conglomerate, the small Tionesta Coal, from 12 to 18 inches thick. In the shale above the coal occurs a seam of not very good coarse-grained bluish iron-ore, a very easy ore to work, and said to be a profitable band. It lies in two or three layers of nodules, varying from 15 inches in diameter to the size of a hen's egg. This ore has been opened in several localities, and was before noticed on the E. side of the Alleghany River. It is easily recognised, as no other bed has been discovered between the two heavy sandstones in the vicinity of the Alleghany. At the base of the conglomerate, bog-ore is found in several places along Scrubgrass Creek, on the run which empties into it, one-fourth of a mile above its mouth, and at Cross's furnaces.

The Tionesta Sandstone, with the upper part of the conglomerate, is seen in the deep hollow of Scrubgrass Creek, on the road from Franklin to Warrensville. The strata resting upon the upper of these two heavy beds are well seen in the adjacent hills. The following short section was taken one-third of a mile S. of the Creek:—

Ferriferous Limestone; Shale, 5 feet; Bituminous Shale and Coal, 1½ feet; Shaly Sandstone, 5 feet; *Clarion Coal,* 3 feet; Bluish Shale, 35 feet; Black Slate; *Brookville Coal,* 18 inches; Shale, 5 feet; Tionesta Sandstone.

The limestone is found in the immediate vicinity, and where the whole stratum exists is about 15 feet thick, of a blue colour, and *unaccompanied by the buhrstone and its ore.* We here for the first time meet with an interposed seam of coal between the limestone and the Clarion Bed. It is never more than 20 inches thick, is slaty, and frequently immediately underlies the limestone. It may perhaps be considered as an upper member of the Clarion Coal, subdivided by the intercalation of slate.

The *Brookville Coal* in Venango County and Northern Butler is only on an average 18 inches thick, and is but a few feet above the Tionesta Sandstone.

At Messrs Johne's and Bradley's, in Sandy Lake Township, Mercer County, the limestone consists of two distinct strata, separated by a band of calcareous clay, with a seam of coal. The upper portion is a light-grey compact bed, about 3 feet thick. The clay is bluish, with a seam of coal from 1 to 6 inches thick, the whole

being from 12 to 15 inches in thickness. The lower portion of the limestone is blue, earthy, less compact than that above, and only sparingly fossiliferous : 4 feet of it are exposed, but it is said to be 6 feet thick.

Three-quarters of a mile S.W., the Clarion Coal is seen 15 or 20 feet below the limestone : it is 3 feet thick, and overlaid by shale. The Scrubgrass Seam was not detected here, and has probably thinned out. These two beds of coal, with the limestone which overlies them, occur in isolated patches over the greater part of Scrubgrass and Irvin townships in Venango County, and a large part of Wolf Creek Township in Mercer County. In the N. part of Butler this limestone is abundantly met with, but is usually destitute of iron ore and chert. In the N. townships of Butler County it begins to occupy a lower position in the hills, and the Kittanning Bed is found near the summits of some of the most elevated. It is hardly possible to trace the irregular outcrop of this seam, but in general it very nearly follows a line parallel to the county-line between Butler and Venango, but about 1½ miles farther N. to the White Oak Spring, and thence to the Pittsburg and Erie Turnpike, at the S.E. corner of Springfield Township.

The *Clarion Coal-bed* is mined in several places in the N. part of Butler County, until it assumes so low a relation to the water-level as to be inaccessible. It is mined at Mr Leonard's, where it affords an excellent fuel ; and in the neighbourhood of Lawrenceburg, in Mercer Township, at Mr Criswell's, and 2½ miles to the N.E., where it is 6 feet thick. It here lies near the base of the hill, and yields a very excellent solid coal, parted by about 3 inches of slate. The Ferriferous Limestone is very generally met with through the whole of this part of Butler County, sometimes accompanied with the chert, but usually destitute of the iron ore. The latter is observed as we approach Centreville, and 4 miles E. of that village it is from 6 to 20 inches thick. Sometimes it is almost wholly replaced by the buhrstone, which is often a foot in thickness, and rests immediately upon the limestone. At Buchanan's, 2 miles from the village, the ore and buhrstone average together about 8 inches in thickness, and are often separated from the limestone by as many inches of clay : the buhrstone is not, however, abundant ; it is of a greyish or cream colour, and has a cellular structure.

At a higher level we observe the Kittanning Coal-bed : it has been opened 2 miles S. of Harrisville ; is rather shaly, but burns well ; is from 4 to 4½ feet thick, and usually covered by slate. The Freeport Sandstone is frequently seen at the tops of the hills containing it.

It extends through Venango Township, and has been opened near Lawrenceburg, but is not so profitable a bed as the Clarion Coal below the limestone. In the middle district of the township the seam is sufficiently thick, but the coal is slaty and impure.

The following section was compiled in the vicinity of Lawrenceburg — (See Fig. 422) :—

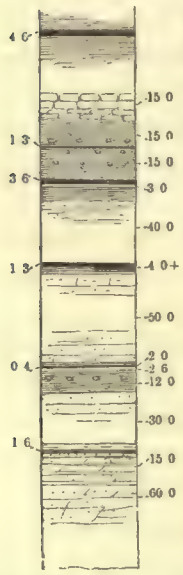


Fig. 422.—Lawrenceburg.

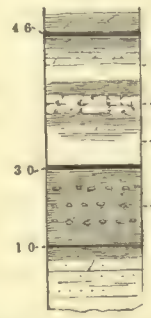


Fig. 423.—Slippery-Rock Creek.

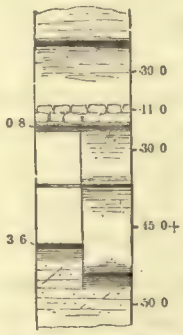


Fig. 424.—Beaver River, Newcastle Turnpike.

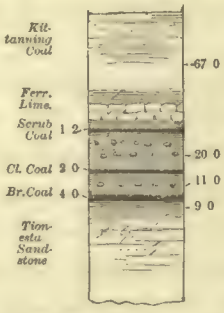


Fig. 425.—Neshannon Little Branch.

Olive and Brown Slate ; Ferriferous Limestone (chert), 15 feet ; Shale, 15 feet ; *Scrubgrass Coal*, 15 inches ; Brown Shale (ore), 15 feet ; *Clarion Coal*, 3½ feet ; Fire-clay, 3 feet ; Sandstone, more or less slaty, 40 feet ; *Brookville Coal*, 1¼ (4?) feet ; Tionesta Sandstone, 50 feet ; *Black Slate*, 2-feet *coal* (Tionesta Bed), 4 inches ; Fire-clay, 2½-feet shale, with one band of iron ore, 12 feet ; Sandstone, 30 feet ; *Bituminous Shale*, 2½ feet ; Slaty Sandstone, 15 feet ; *Fire-clay*, with vegetable remains, 15 inches ; Sandstone, sometimes massive, 60 feet.

The Kittanning Coal-vein is found on the hills farther back from the river. The fire-clay underneath the Clarion Coal is good, and has been taken to Pittsburg. The thickness of the Brookville Bed is not known with precision : in one place it was ascertained to be but 15 inches ; but a 4-feet seam S. of Lawrenceburg is supposed to be the same, although it may possibly be the Clarion Bed.

One mile above Lawrenceburg, opposite the mouth of the Clarion River, the Ferriferous Limestone occupies

the highest hills in massive ledges upon Mr Robeson's land. It is underlaid by slate or shale, 15 feet thick, descending to a small seam of coal not exceeding 18 inches in thickness. About 15 feet beneath the latter the main bed of the district (Clarion Coal) is opened. Its thickness varies from 3 feet 6 inches to 5 feet, averaging 3 or 4 feet of good coal. Several thin bands of slate containing pyrites are interstratified with the coal. Some distance below this bed a small seam, perhaps 6 or 12 inches in thickness, appears to represent the Brookville Coal. The bed is slaty and valueless. In the shales associated with this seam, iron ore has been found; several hundred tons have been carried to Kensington Furnace, opposite Emlenton. The ore has not proved abundant, and is difficult to smelt.

Tracing the several beds W., we can perceive them subject to very little variation, unless it be in the thickness of the strata between the coals. A depression in the general surface of the country in Wolf Creek Township prevents the limestone from outcropping in as regular a line as it does in Venango County. It is seen near the base of a high knob on the Old Pittsburg Road, 7 or 8 miles S. of Mercertown, as a light-blue limestone, 15 feet thick. A short distance below it is the *Clarion Coal*, which is not opened in this immediate vicinity, but its position is well marked. The *Brookville Coal-bed* is seen near the top of a hill 2 miles farther N. at Springfield Furnace, being separated by only a few feet from the top of the Tionesta stratum, 60 feet thick, and well exposed within a few rods of the Falls. From this place we follow the outcrop of the limestone in a direct line to the mouth of the Little Neshannock, and thence to Newcastle, on the W. side of the Great Neshannock Creek, where but a few points of land are sufficiently high to take it in their summits. In the vicinity of the Shenango, and in all the E. half of Mahoning Township, the general level of the country falls off a little, and does not reach the limestone stratum even at its highest points, with the exception of the high ridge which runs down from the N.W. to the Mahoning, between Youngstown and New Bedford. At the lower end of this ridge, where the Newcastle and Poland Road crosses it, the Ferriferous Limestone is again seen. This, with the exception of a small outlying patch S.E. of New Bedford, is the last knob capped by the Ferriferous Limestone towards the N.W. The surface of the country declines to a lower level N. along the line of this outcrop of Ferriferous Limestone, which served as a partial protection to the underlying coals and their including shales against the general denudation. Their outcrops, therefore, correspond geographically with its own. The lower lever is that of the Tionesta Sandstone, which overspreads the greater part of Lackawanna Township.—(See Fig. 426.)

Fig. 426.—Lower Coal-measures, N.W. Corner of Lawrence County.

The country for some miles S. of this line is well supplied both with coal and limestone. The smallness of the angle at which the beds dip towards the centre of the basin makes them accessible over a wide area. This condition of things gives great advantages to the farming region of this basin over the country traversed by the several axes farther to the E. It will be needless to specify the very numerous localities at which the limestone and the two underlying coal-beds occur in their broad range through the townships of Wolf Creek, Slippery Rock, and the S.E. part of Neshannock in Mercer County, Slippery Rock and Muddy Creek townships in Butler County, and Shenango, North Sewickly, North Beaver, Little and Big Beaver townships in Beaver County; but in connection with the overlying strata we shall have frequent occasion to refer to these. Over this area, with the exception of Wolf Creek Township and the neighbourhood of Centreville, neither the chert nor the iron ore is seen in connection with the Ferriferous Limestone. At the bridge over Slippery Rock Creek, on the Butler and Mercer Turnpike (see Fig. 423), we have at the water-level the Tionesta Sandstone; a few feet of brown shale separate it from the Brookville Coal-bed, here a mixture of bituminous shale and coal 12 inches thick. Above this rests the great repository of the oolitic iron-ore, usually a brown or yellowish shale, sometimes an argillaceous sandstone, in which case the iron ore is in less abundance. The whole stratum is here about 40 feet thick. Upon this rests the *Clarion Coal*, 3 feet thick; 25 feet of shale and slaty sandstone separate this from the Ferriferous Limestone, which is from 12 to 14 feet in thickness, of a bluish colour, and tolerably compact. In the neighbourhood of this locality, the Kittanning Coal is repeatedly seen from 3 to 4 feet thick, and covered by a heavy bed of brown shale, containing some argillaceous shaly sandstone, and occasionally

a considerable quantity of nodular iron-ore. This ore was formerly mined for an old furnace on Slippery Rock Creek. Approaching Newcastle, the limestone is abundantly found, as was before stated, being there nearly at its outcrop. The Kittanning Coal is likewise found E. of the town, and S. of the Neshannock, and is from 19 to 32 feet above the limestone. At Ray's, a small bed of coal (Scrubgrass Coal) is found immediately below the limestone; and 22 feet above it is the Kittanning Bed, 3½ feet thick, capping the very highest points of land. The right-hand portion of the column represents the following Section made at Newcastle (for its continuation to water-level, see Fig. 424) :—

Flaggy Sandstone. *Kittanning Coal*, 3½ feet; Fire-clay, 2 feet; Shale and Sandstone, 30 feet; *Ferriferous Limestone*, 11 feet; *Scrubgrass Coal*, 8 inches; Fire-clay; Shaly micaceous Sandstone and brown shale, 30 feet; *Clarion Coal*, 2½ feet; Fire-clay; Argillaceous sandstone, 45 feet, or more; *Brookville Coal*; Brown Shale; Tionesta Sandstone.

The *Clarion Coal Vein* is worked at Henkson's and Ray's, and elsewhere: it is usually overlaid by shale holding a few scattered nodules of argillaceous iron-ore, and underlaid by brown shale and argillaceous sandstone. On a small stream, which empties into the Neshannock on the S. side, the following section (see Fig. 425) was obtained :—

Limestone; Shale, a few feet; *Scrubgrass Coal*, 14 inches; Shale with ore, 18 to 20 feet; *Clarion Coal*, 2 feet; Shale with ore, 11 feet; *Brookville Coal*, 4 feet; Brown Shale, 9 feet; Tionesta Sandstone.

The farm of Dr Whippo is the nearest locality to Newcastle, where the limestone is found; it is there well exposed: also on the road to Butler, about 1½ miles from town, its fragments are strewed over the high ground over which the Newcastle and Conequenessing Road passes, 1½ or 2 miles from town.

The *Brookville Coal-bed* is opened on Dr Whippo's farm, and is 61 feet below the base of the limestone, and 3½ thick, yielding a sort of cannel coal, and mining with a cubic fracture.

The distance of the *Kittanning Coal* above the Ferriferous Limestone increases Southward toward the mouth of the Beaver River, while the two lower coals diminish in size in the same direction. The strata dip gently S., bringing the limestone, which at Dr Whippo's, near Newcastle, stands 300 feet above the Neshannock water-level, down to 42 feet above the Beaver River water-level at Whampoa Hill, 3 miles above the mouth of the Conequenessing. Allowing for the fall of water, 235 feet is left for the amount of dip in that distance.

At Whampoa Hill the Kittanning Coal-bed is separated from the limestone by 67 feet of strata, this increase in the distance being occasioned by the great augmentation of silicious layers which occupy the intervening space. Above it rest many feet of flaggy sandstone and shales, which are here the representatives of the Freeport Sandstone, and the shale and slate which underlie it. The Kittanning Coal-bed on the W. side of the Beaver River outcrops on the high land S. of Hickory Creek.

CHAPTER XVII.

SIXTH BASIN WEST OF THE ALLEGHANY RIVER—FREEPORT GROUP.

THE N.W. outcrop of the *Lower Freeport Coal-bed* crosses the Alleghany River in the hill-tops, a mile above Miller's Eddy, and the Butler and Little Scrubgrass Creek Road, and about 2½ miles S. of the N. line of Parker Township, or 6 miles S.W. of Lawrenceburg. Here it bends, and runs in a straight line to the Mercer Turnpike, 12 miles from Butler, and 1½ S. of the Stone Tavern, and onwards to Slippery Rock Creek, 3 or 4 miles above its confluence with the Conequenessing, crossing Beaver River, 3 miles above the mouth of the Conequenessing, where it is a fine bed, 6 feet thick.

Its line of outcrop then passes S. of Whampoa Hill in an undulating course, through Big and Little Beaver townships, and 3 miles to the N. of Greensburg to Fairfield in Ohio.

The S. line of outcrop of this bed, running S. of Curlsville, past Roseburg, to the Alleghany River, at the

nouth of Red Bank Creek, after crossing the river follows a S.W. course, but gradually approaches the line of he fifth anticlinal axis, and at length arches over it at the forks of Buffalo Creek, 2 miles above the Butler and Kittanning Turnpike, on the W. side of the Creek.

Outside of the limits of the area included between these lines, the Freeport Coals are nowhere seen. Along ts limits runs the Freeport Sandstone, which supports the series towards the E. It is a well-characterised, soft, ellowish, clear-grained sandstone, disposed to massiveness, but sometimes slaty; towards the W. running into ilicious slates and thinly-bedded sandstones. It is usually about 50 feet thick, and overlies a very irregular group of soft argillaceous shales, which furnish the variable element in the unequal interval between the Kittanning and Lower Freeport Coal-beds. A great variation of interval is produced also by unequal denudaion acting upon these same lower and softer rocks.

The Upper Freeport Coal, it was before stated, is separated from the lower bed by slate and slaty sandstones usually about 40 feet in thickness, and of course occupies a similar but smaller geographical area; its regular ine of outcrop is usually from 2 to 3 miles distant from the former. From the Alleghany River Hills, about 2 miles above the mouth of Catfish Creek, it ranges W. in an undulating line across the road from Bear Creek Furnace to Fairview, within a mile of the latter place; thence N.W. to a knob high on the Butler and Little Scrubgrass Road, S. of the Six Cross Roads in Parker Township. Bending again like the outcrop of the Lower Freeport Bed, it proceeds directly to the Mercer Turnpike, 2 miles N. of Unionville. In this neighbourhood, however, it is not very easily traced, but traversing the high and little-broken country to the W., it strikes the Conequenessing 4 or 5 miles below the mouth of Slippery Rock Creek and the Beaver River, about 3 miles above Old Brighton Bridge. From the Beaver River it pursues a N.W. course to the Church, one third of a mile N. of Greensburg, and thence runs W. into the State of Ohio towards New Lisbon.

This line marks the N. outcrop of the Upper Freeport Bed, while the Freeport Limestone which underlies it extends its own outcrop only in a few instances beyond hat of the coal.

The S.E. outcrop in this basin may be described by a tolerably straight line drawn rom the hill N. of the mouth of Red Bank Creek to the Butler County line, where it is rossed by the Buffalo Creek N. of the Kittanning Turnpike; and thence to the back f the axis, 2 miles N.E. of Hannastown.

As the medial line of the Sixth Basin crosses the Alleghany River below the mouth f Sugar Creek, the hill-slopes, upon which the harder rocks stand out in picturesque liffs, afford admirable exhibitions of the rocks from as low down as the upper layers of he Seral conglomerate in the bed of the river, to almost the uppermost strata of the Freeport series. This the following section (Fig. 427) will show:—

Sugar Creek Section, Great Western Furnace.—Shale and Slate, 60 + feet. *Upper Freeport Coal*, 4 feet 6 inches (at the Summit Coke-yard the bed is 6 feet thick); Fire-clay and Shale, with beds of nodular iron-ore 2 inches thick, 7 feet 6 inches. *Freeport Limestone*, 5 feet; Fire-clay, 18 feet. *Calcareous Ore*, "Summit Bed," 2 to 2 feet 6 inches; Fire-clay, 20 inches; Sandstone, 30 feet. *Lower Freeport Coal*, 15 inches (in Phillips' Hill, 4 feet); Shale, passing downwards into slaty thin flaggy sandstone (Freeport S.), 65 feet. *Coal*, 10 inches; Fire-clay, 2 feet; Sandstone more or less massive, including a thin band of worthless silicious ore, 62 feet. *Kittanning Coal*, 3 to 4 feet; Fire-clay, 4 feet; Shales, olive and blue, including a stratum of bituminous shale, which locally becomes cannel coal, 5 feet thick; Argillaceous Sandstone and concretionary iron-ore, 40 feet. *Silicious Iron-Ore*, "Slab Vein," 20 inches; Sandy Shale, 12 feet. *Ferriferous Limestone*, 15 feet. *Ore*, 4 to 10 inches. Shale, blue and slaty sandstone, 40 feet. *Clarion Coal*, 2 feet; Fire-clay, 2 feet; Shale and Sandstone, 30 feet. *Bituminous Shale*, 0; Shale, 25 feet. *Bituminous Shale and Coal*, 12 to 18 inches. White Sandstone (Tionesta), 60 feet; Bituminous Shale interlaid with sandstone, 20 feet. Seral conglomerate.

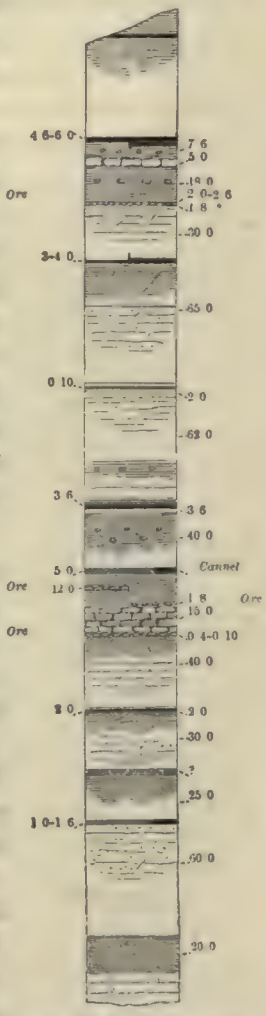


FIG. 427.—Great Western Furnace, Sugar Creek.

The bed of coal wrought for coking at the Great Western Furnace is the Upper Freeport Coal, which is found the best. The Kittanning Coal-seam supplies the rolling-mills with fuel, and is wrought to a limited extent for furnace use.

The iron ore constituting the main dependence of the furnaces is the calcareous ore underlying the Freeport Limestone known as the "Summit Vein." Though it averages not more than 2 feet or 2 feet 6 inches in thickness, it has been found, in the Phillips' Hill, 4 feet thick. The ore yields 30 per cent metal in the furnace. The stratum of fire-clay over the ore is used for making fire-brick, for which it is admirably adapted. Before its discovery, that beneath the Kittanning Coal was used. The "Slab Vein" of ore fluctuates both in character and distance from the limestone beneath. When separated from the limestone by sandy shale, it is a silicious buhr-stone ore, but, approaching the limestone, it becomes more calcareous and scaly. In some places it is highly impregnated with bituminous matter and sulphur. Its dimensions are quite uniform. The average yield of the ore in metal is from 35 to 37 per cent.

The Elk Lick Coal-bed here makes its appearance on the highest ground back from the river as the largest bed in the section: it is 50 feet above the Upper Freeport Coal, and is fully 5 feet thick. We shall hereafter notice it again at Alleghany Furnace.

The small interpolated bed beneath the Freeport Sandstone is said to be found farther W. on the lands of the Brady's Bend Coal and Oil Company, much increased in thickness, and in the form of *cannel coal.* The bed is reported by Professor Owen to be from 2 feet 6 inches to 3 feet 10 inches in thickness. The specimens from the seam indicate a light compact cannel-coal, having a conchoidal fracture. It is proposed to extract lubricating and illuminating oils from it.

Some beds of the thick sandstone stratum near the base of our Sugar Creek section are formed of pure white sandstone, suitable for glass-making. Large quantities of the rock have been shipped to Pittsburg for that purpose.

The Great Western Iron Furnaces are situated on Sugar Creek, 2 miles above its mouth. There are four stacks for the smelting of iron, of which two are 50 feet high, 14 feet across the boshes, and 7 feet diameter at the trundle-head; and two 45 feet high, 11 feet bosh, and 6 feet at the trundle-head. They all employ hot-blast. Connected with these, an extensive rolling-mill at the mouth of the creek moulds the iron into the form required.

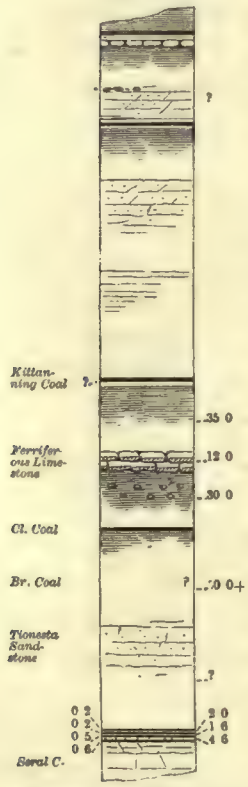


FIG. 428.—Alleghany River, 7 miles above Sugar Creek.

Fig. 428 represents a section made upon the Alleghany River at Miller's Eddy, 7 miles above the mouth of Sugar Creek; it reads as follows:—

Upper Freeport Coal, roof, shale; floor, fire-clay, 3 feet thick. *Freeport Limestone,* 0; Shale and shaly Sandstone, 40 feet. *Lower Freeport Coal,* small, interval 135 feet, in which occurs the contorted Freeport Sandstone. *Kittanning Coal;* Shale, 35 feet. *Ferriferous Limestone,* 12 feet; Shale, with nodules of argillaceous ore, 30 feet. *Coal,* and interval, 50 feet. Tionesta Sandstone. *Coal,* 2 inches; Shale, 2 feet; *Coal,* 2 inches; Argillaceous Sandstone, 18 inches; *Shaly Coal,* 5 inches; Argillaceous Sandstone, 4½ feet; *Coal,* 6 inches; Seral conglomerate.

This section is not more than 4 miles distant in a straight line from the last.

The Upper Freeport Coal and the underlying limestone here make their final N. outcrop.

Leaving the river and going W. we find the two Freeport Coal-beds frequently opened within their respective areas, but more frequently the upper one, which is usually the thickest, and affords the purest coal. In the neighbourhood of Fairview it is extensively mined.

The Elk Lick Coal occasionally appears, but nowhere as a workable bed, along the central line of the basin.

At Butler the Freeport Sandstone is seen along the valley-sides of the Conequenessing Creek. The Catholic Church is built upon it, and partly of stone quarried from it. The stone is considered to be, for building purposes, the best in the neighbourhood. The whole stratum is here about 50 feet thick.

The *Lower Freeport Coal* may be found at or near the water-level of the Conequenessing. It has been dug into at various points, but has never been fairly proved. On the land of Mr Boyd, a short distance E. of the town, a coal-bed near the creek-level was opened: it is said to be 2 feet thick, and of the cannel variety. This is a condition in which this seam is frequently found.

The *Upper Freeport Coal* passes through the town at about the level of the pavement of Zimmerman's (formerly Hamilton's) Brick Tavern, and was cut in digging for the foundations of the New Court-house. It has been extensively wrought by Messrs Neighley, M'Laughlin, Bradin, Shäffner, and others. At Shäffner's (formerly Bradin's) Bank, 1 mile S. of the town, the bed is 4 feet thick, the upper 12 or 18 inches of it being sometimes cannel coal.

Upon the Old Pittsburg Turnpike several drifts have been opened upon the bed, and it yields in all of them its usual thickness of 4½ feet of good coal. Small faults or dislocations have been developed in this vicinity; and fissures occur in the bed from a few inches to 3 or 4 feet in width: these are usually filled up with clay; the faults are sometimes, but not always, downthrows. Where a gangway is driven past a fault, the drainage of the land above will cause its abandonment. If the dislocation be so great as to make it troublesome to find the bed upon the farther side of the fault, it is considered more profitable to abandon the drift, and begin another from the outcrop.

The Elk Lick Coal may be seen high on the Plank Road Hill, S., and on the turnpike N. of the town, near the Cemetery. Its thickness varies from 9 to 15 inches.

The Freeport Limestone occurs in the form of nodules, imbedded in a white or grey calcareous clay, containing minute fossils exceedingly difficult to collect uninjured. It appears at several drifts on the Old Pittsburg Turnpike, and within a mile or two E. of the town; also in the street descending W. from the Court-house.

Above the thin Elk Lick Coal-bed, in this neighbourhood, is a stratum exactly resembling the variegated shale seen at the turnpike-gate near Kittanning, on the Indiana Road. In it are frequently found small calcareous ferruginous nodules, while the shale itself, especially the blue variety, contains a slight intermixture of calcareous matter. Its thickness is unknown, but it must be considerable. It is probably that member of the Barren Measures which is seen at the mouth of Sawmill Run, and at other points along the base of the hills at Pittsburg. The upper half of many of the hills for 3 miles N., and 4 miles E. of Butler, consists of these variegated shales; but as we approach the fifth anticlinal axis 4 miles E. of Woodville, the sandstone and slate which overlie the upper Freeport Coal-bed shut them out from the tops of the hills. This axis, after passing Hannastown, is little more than a broad gentle undulation in the strata, rapidly dying out S.W. The variegated shales appear beyond it to the S.E., in the neighbourhood of Pughstown, near the county-line, and 7 miles from Freeport. A thin sandy ferruginous blue or brown limestone, abounding in fossils, overlies the last-mentioned shale stratum. This limestone has a wide range, being found on the Little Mahoning, on the highest hills near Kittanning and S. of the Kiskiminetas. Beneath it, and separating it from the shale, is a seam of hard brilliant coal, varying in thickness from a few inches to 1½ feet, but by no means constant, having been noticed in the present district in only a few instances: it is wanting at Kittanning and at Little Mahoning. It is usually from 6 to 8 inches in thickness. The limestone is found in most of the hills immediately around Woodville, and may be seen in the bank of the Butler Turnpike, about half a mile from the bridge, and probably 40 or 50 feet from the top of the hill. As the basin deepens towards the S., it occupies a wider area, and is found lower in the hills. It is from 1 to 2 feet in thickness, covered by olive or blue slate (see Fig. 429). Four and a half miles from Woodville, the upper *Freeport Coal-bed* is seen a few feet above the water of Glade River. It is here, as at Butler, overlaid by brown shale; sandstone occupies the upper part of the hill. The seam is here about 2 feet thick, and yields a good coal. The Freeport Limestone is seen in the bed of the creek.

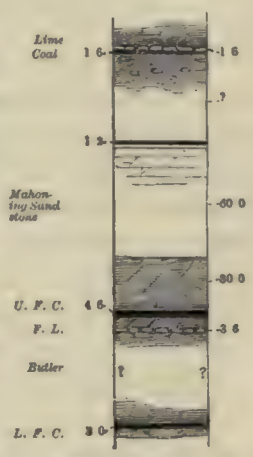


FIG. 429.—Zelienople and Harmony.

The description given of the strata around the town of Butler applies to the surrounding country.

Between Butler and Harmony few exposures are seen; the banks of the Conequenessing slope gently, and are covered with detritus concealing the strata. At Harmony and at Zelienople the lower Freeport Coal has been opened in several places. It rests here on blue shale, and is about 5 or 6 feet above the creek at the mill, half a mile W. of Harmony. It is from 2½ to 3½ feet thick, and frequently contains sulphuret of iron. The shale beneath it, which is blue or brown, and here represents the upper part of the contorted sandstone, contains a few scattered nodules of argillaceous iron-ore. Above the coal is shale and argillaceous sandstone, some portion of the former being slightly bituminous, and containing a few marine organic remains. The upper Freeport Coal-bed is poorly developed, but is found, together with its limestone, in the hill opposite Zelienople.—(See Fig. 429).

Five or six miles S. of Harmony, the variegated calcareous shales of the Barren Measures again appear, as described in the neighbourhood of Woodville or the Glade Mills. The shale here outcrops in the tops of the hills as through the middle and northern portions of Economy Township, and northern portions of Hopewell Township, on the opposite side of the Ohio River. The black fossiliferous limestone is found occupying its usual portion a little farther S., and is occasionally accompanied by the thin underlying coal-vein.

At Burns's Tavern, near the county-line, upwards of 10 miles S. of Harmony, a greenish non-fossiliferous limestone, rather impure, and breaking into rhombic or cubic pieces, is seen in connection with much red soil. Its thickness is about 3 feet, but it is too impure to be employed at the kilns. This is the second bed of limestone above the waters of the Ohio at Pittsburg, and will be more particularly described along the Kiskiminetas.

All the hills between Conequenessing Creek and the Beaver River, from a mile or two below the mouth of Brush Creek to the Harmony and Beaver Road, are occupied by the Barren Measures. In the hollows, however, especially towards the mouth of Brush Creek, the Upper and Lower Freeport coals crop out, both of them being exceedingly irregular in thickness. Not unfrequently the upper seam is reduced to only a few inches, or wholly absent; and then again, within a fourth of a mile, it may be a workable bed. These sudden changes in thickness are characteristic of this coal, as we shall see in tracing it through Westmoreland County. The brown shale which, at Sugar Creek and Butler, was seen resting upon the coal, is here frequently replaced by flaggy sandstone, forming the roof of the bed, which is generally thin. The limestone below it is remarkably constant in its attendance upon the coal.

CHAPTER XVIII.

FREEPORT GROUP, SIXTH BASIN, AND COUNTRY WEST OF THE BEAVER RIVER.

In the hills of the Beaver River there are fine exposures of all the rocks, from the middle of the Barren Measures down to the Tionesta Sandstone. Sections of the lower rocks at Newcastle, &c. have already been given; but as we descend the stream, these sink one by one below its bed, until the massive stratum of the Ferriferous Limestone is seen half out of water in the Ohio River banks, at the mouth of Ten-mile Run (see Fig. 433). The massive sandstones of the country to the N.E. and E. are here represented by far softer rocks, slates, and shales; and the relative distances of the beds from one another are also different. The approximation of the Kittanning and Lower Freeport coals, for instance, is very striking. The Ferriferous Coal seems to be entirely wanting. The Freeport group is greatly enlarged, while the Ferriferous Limestone swells to a size even beyond that which characterises it upon the Alleghany at Kittanning.

The following section (Fig. 430) was taken in Trough Run above the upper bridge, on the E. side of the Beaver River, and nearly opposite the Old Brighton Iron-works. The upper layers of the Tionesta Sandstone may be seen approaching the water-level of the Beaver at the bridge, and form part of the falls at Patterson's Dam, between Falston and Old Brighton Bridge:—

Sandstone, flaggy, 60 feet; Coarse brown Shale, 7 feet. *U. F. Coal*, 1½ feet; Clay and Shale, 4 feet.

F. Limestone, rather nodular, 3 feet; Blue and brown Shale, 37½ feet. Slaty Sandstone, 35 feet; Light-brown Shale, 3 feet. *L. F. Coal*, 1½ feet. Fire-clay, 4 feet; Shale, light brown, 7 feet; blue, 2 feet; olive, 6½ feet. Shale and slaty

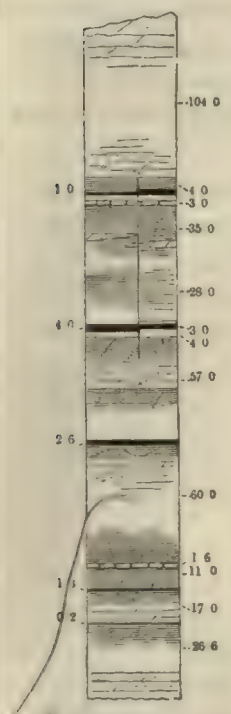


Fig. 430.—Beaver River.

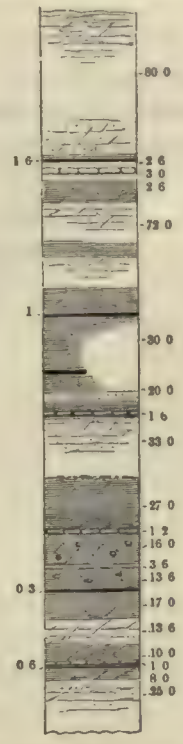


Fig. 431.—Old Brighton.

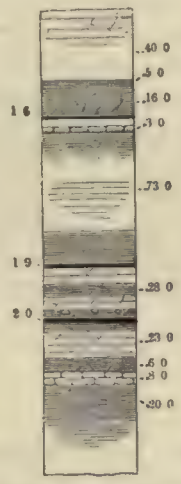


Fig. 432.—Below New Brighton.

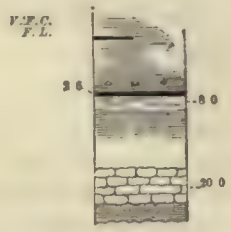


Fig. 433.—On Ohio River.

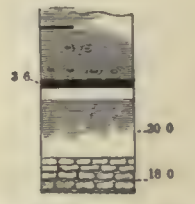


Fig. 434.—Ohio River, Six-Mile Run.

Sandstone, 12 feet; Brown Shale, 30 feet. *Kittanning Coal*, 2½ feet; Light Shale, 7 feet; and Shale, argillaceous, micaceous, sandy, brown, and drab, slaty, 40 feet; Shale, blue, 13 feet. Ferriferous Limestone (?) 1½ feet; Shale, slaty, 6½ feet; Sandstone, 4½ feet. *Clarion Coal*, 1¼ feet; Shale, olive and brown, 7 feet; Sandstone, 19 feet. *Brookville Coal*, 2 inches; Brown Shale, 26½ feet; Tionesta Sandstone, upper, 8½ feet exposed. The level of the Beaver River is here 69½ feet above that of the Ohio at Bridgewater.

Upon a fork of Trough Run the following series of rocks was observed, and used to complete the upper part of vertical column, Fig. 430:—

To top of hill, 25 feet. Slaty Sandstone, &c., 104 feet. *U. F. Coal*, 3 feet; Brown Shale, 84 feet. *L. F. Coal*, 4½ feet—a semi-cannel coal, not soiling the fingers in handling it. This variation from 1½ to 4½ feet takes place within the space of a quarter of a mile.

The absence of the great Ferriferous Limestone in this Trough Run section is remarkable.

By careful comparison of the columns containing it, it will be found to diminish constantly N.W. from the medial line of the Sixth Basin. The impure limestone, 1½ feet thick, abounds in organic remains. This is replaced in a little run at the back of Old Brighton, by a bed of black calcareous shale, studded with small fossil-shells.

In a small gully below Old Brighton Bridge, and above Patterson's Dam, the following section (see Fig. 431) was obtained:—

Sandstone, thick and thin, 80 feet; Brown Shale, 2½ feet. *U. F. Coal*, 1½ feet; Fire-clay, 2½ feet. *F. Limestone*, 3 feet; Fire-clay, 3 feet; Shale and Clay, 12 feet; Shale, fossiliferous, ferriferous; Shales alternating with thin sandstones, with many fossil plants, 60 feet. *L. F. Coal*, 9 to 12 inches; Clay and shale, 17 feet. Interval containing the *Kittanning Coal*, 12 feet; Shales, 13½ feet; Argillaceous Sandstone, 4 feet; Shale, calcareous, 3 feet; *Arenaceous Limestone*, 1 to 2 feet; Slaty Sandstone with calcareous argillaceous shales, 33 feet; Drab Fossil Slate and Brown Shale, 27 feet. *Ferriferous (?) Limestone*, 14 inches; Blue slightly bituminous Slate, with ore, 16 feet; Fire-clay 3 feet; Light-coloured Ferriferous Shale, 13½ feet; Argillaceous Sandstone, 2 feet; *Bituminous Shale*, 3 inches; dove-coloured

Shale, 17 feet; Reddish-brown Sandstone, 13½ feet; Shale, 10 feet. Limestone, 1 foot. Coal, 6 inches; Brown Shale, 8 feet; Flaggy Sandstone, 25 feet exposed to water-level, 54½ feet above Ohio water-level at the mouth of the Beaver River.

Here it will be seen that 130 feet of shales, and massive (Freeport) sandstone, have dwindled down to 28 feet of shales and thin sandstones, between the Kittanning and Lower Freeport coals, almost wholly removing the elsewhere so strongly marked partition between the Clarion and Freeport series of Coal-measures.

The following section (Fig. 432) was got from a run opposite, and a short distance below, New Brighton:—

Slaty Sandstone, to the top of the hill, 40 feet. Drab-coloured Shales, 5 feet; Bluish grey, 16 feet. *Upper Freeport Coal*, small; Fire-clay; Shale. *Ferriferous Limestone*, nodular, 3 feet; Shales, sometimes bituminous; Slates, Flags, probably 70 feet; Brown Shale, 3 feet. *Lower Freeport Coal*, 1½ to 2 feet; Flag-sandstone, 11 feet; Shales, 6 feet; Ferriferous, 11½ feet. *Kittanning Coal*, 2 feet; Shale, slaty Sandstone, 23½ feet; Shales, 6½ feet. *Ferriferous Limestone*, 8 feet; Shale, &c., 20 feet—to the river about 30 feet.

The small section taken at Fallston, directly opposite, differs materially from its proper representative portion in the section just given, as will appear from the following description:—

Lower Freeport Coal; Brown and olive Shales, 40 feet. *Kittanning Coal*, good, 3 feet; interval of 55 feet. *Ferriferous Limestone*, here only 1 foot thick, but rising in the hills, and increasing in thickness and pureness Northwards, until it enters the New Brighton Section (Fig. 432) as 8 feet thick.

The hills in the neighbourhood of Phillipsport are crowned by the representative shales of the Freeport Sandstone.

The Upper Freeport Coal rises from beneath the Ohio River, in the neighbourhood of Crow's Run, towards the N.W., at an angle of one degree. Its final outcrop ranges through the S. portion of Little Beaver Township: it ranges therefore, ever varying in thickness and quality, through Chippewa, Brighton, South Beaver, and Ohio townships.

North of the Ohio, and W. of the Beaver River, the variegated shale of the Barren Measures is not discoverable, but it occurs in New Sewickly on the E. side, and likewise S. of the Ohio, in Moore and Green townships. The N. corner of Economy Township may have the small fossiliferous limestone which overlies the shale.

The *Kittanning Coal-Bed* has been opened on the banks of the Ohio, below the mouth of the Beaver River, in several drifts a little below the village of Phillipsburg. It rests upon a bed of good fire-clay, which in turn overlies brown shale and slaty sandstone, while the upper margin of the Ferriferous Limestone is just below the water-mark. The roof of the coal is brown shale containing a *Pecten*, and above this other ferriferous shales, and then sandstones. Above the coal is brown shale containing a few scattered nodules of blue argillaceous iron-ore. The layer of thin shale next the coal, and which forms its roof, is slightly bituminous, and occasionally contains a small Pecten. Above the shale is a thick mass of alternating shales and slaty sandstone.

Farther down the same side of the river, the fire-clay is wrought, and the bricks sent to Pittsburg; and also on the opposite side of the river, 3 miles below Beaver, where it is 8 feet thick. The clay is good, and the bricks have hitherto found a good market. The coal resting upon it is 2½ feet thick, and probably 30 feet above the Ferriferous Limestone.

At Six-mile Run (see Fig. 434), at a small village called Industry, the Kittanning Bed yields 3½ feet of excellent coal. Beneath it is a bed of slaty sandstone, the lower part of which is in some places massive, exhibiting, locally, highly-inclined planes of deposition. Above the coal-seam is a similar brown shale with that at Phillipsburg, containing the same kind of argillaceous bluish iron-ore. This latter continues up the hill as far as the strata are exposed, probably 45 feet. From this bed, which is generally miscalled "The Fallston Vein," the inhabitants of the surrounding country and the various manufactories draw their chief supply. Indeed, it is the only bed, from the mouth of the Beaver River to the Ohio State line, that can be depended upon, and the fuel obtained from it is certainly of a very superior quality.

The *Ferriferous Limestone* at the Two-mile Run is from 18 to 20 feet thick, of excellent quality, bluish-

grey in colour, fossiliferous, and 40 or 45 feet above the water-level. It rises Westward, showing itself again at the mouth of Rock Run with a soft, clean-grained, yellow, massive sandstone covering it; and again at the Run, 3½ miles from Beaver. At Six-mile Run its upper edge is at low-water level.

All the strata, from the Ferriferous Limestone upwards, may be found upon the tributary waters of the Little Beaver Creek.

We will now resume the description of the Fifth and Fourth Basins, and carry forward that of the country lying N. of the Conemaugh or Kiskiminetas River, along Red Bank, Mahoning, Crooked, and Black-Lick creeks.

CHAPTER XIX.

COUNTRY WATERED BY THE RED-BANK CREEK, JEFFERSON COUNTY—FIFTH BASIN.

Brookville is situated in the Fifth Basin, 5 miles by the turnpike from its Eastern, and 10 miles from its Western bounding axis.

The Vespertine rocks appear in the valley of the Sandy Lick Creek at Brookville. The Seral conglomerate covers with its fragments the low grounds along all the watercourses, and overspreads much of the country to the N., from which a violent denudation has swept the upper rocks, except in isolated patches forming hills, containing at their summits (especially those towards the Clarion River) the Ferriferous Limestone.

The tracing of the conglomerate is rendered more difficult from its great thickness, amounting nearly to 100 feet, and from the proximate position and similar appearance of the Tionesta conglomeritic sandstone, 50 or 60 feet thick, which overspreads it. Towards the Clarion, the lower mass becomes a true conglomerate, containing pure white pebbles regularly circumbedded, and never larger than a common chestnut. The millstones cut from this rock are never sought for lower down the Clarion than the Armstrong Mills, 3 miles above the Jefferson County line. Below this the rock loses its conglomeritic character. Much building-stone has been cut at the mouth of Clear Run, 5 miles higher up, and also as high up as 15 miles above the mills: this seems the N.E. limit of the pebbly portion of the formation. At Ridgeway it is a mere sandstone. It is seen as a conglomerate in all the ravines of Sandy Lick and Red Bank creeks as far down as Troy, where it sinks beneath the water-level.

The Tionesta Sandstone covers much ground on the road from Armstrong's Mills to Brookville, presenting no cliff exposures, but filling the valleys of the little streams, and covering the flats with fragments: the whole country rolls so gently, that its geological level scarcely varies by one coal-bed.

Beneath the Tionesta Sandstone lies the Tionesta Coal, seen around Troy and elsewhere, and opened half a mile W. of Brookville, a little N. of the turnpike, in the bed of a small run; it occurs in the following strata:—

Hill of soft shales and light sandstone, 50 feet; A wash of slate and shales, 10 feet; Black Slate, 2 feet. Coal, cannel, 2 inches; good coal, 13 inches; slaty, 1 inch; good coal, 3 inches; supported by massive white sandstone.

The pressure of the shales above this exposure incline the observer to consider it a thinner section of the Brookville Coal.

The Brookville Coal-bed is seen upon the hills back of the town, and on the turnpike towards Clarion. It outcrops towards the fifth axis about 5 miles W. of Brookville, and measures 3 or 3½ feet in thickness; also around the sides of a high hill, 6 miles from Brookville on the Warren Road, 60 or 80 feet below the summit, upon which lie the fragments of the Ferriferous Limestone-bed and its valuable ore. At the foot of the hill, below the coal, the outcrop of another bed (the Tionesta Coal) is seen in the opening, appearing thus:—

Cannel Coal, 1 foot; Clay, 1 foot; Good Coal, 1 foot. The interval of from 40 to 60 feet is evidently occupied by (the Tionesta) flaggy sandstone.

The Ferriferous Limestone is seen 2 miles S. of Armstrong's Mills, and the Brookville Coal below it; but

between the two there is a bed of superior iron-ore several inches thick, and above the iron ore (which is not the Ferriferous Limestone ore) is a band of black slate, 2 feet thick, with a few inches of coal, and floored by micaceous sandstone, 5 feet thick, crossed in all directions with the black impressions of the stems of fossil plants. This may be the representative of the Clarion Coal-bed, as in the Strattonville Section (see Fig. 413, p. 569).

In the isolated district of Coal-measures enclosed between the Sandy Lick and Mill creeks N.E. of Brookville, at its N. end, a ridge contains the Ferriferous Limestone.

Fig. 435.—Armstrong's Mill, Clarion River.

On the Curwensville Turnpike the Ferriferous Limestone is not observed, but occurs not far N. of it on the road to Toby Creek. A coal-bed of no considerable thickness (the Brookville Coal) has been opened below it.

The hill, ascending from the Brookville bridge eastward, is composed, at its base, of Vespertine sandstones: these form cliffs along the water's edge at Port Barnet, below the sawmill, where is a quarry of grey flagstone. The rocks of this formation may be thus characterised: They are usually greenish, yellowish, or olive-coloured sandstone layers, from 1 to 5 inches in thickness, finely-grained, argillaceous, containing peroxide of iron in hollow concretions. Shales and shaly sandstone in layers alternate with the flags, and constitute a larger proportion of the whole. They separate the formation also into belts, and greatly predominate at its upper limit, where they contain the shelly argillaceous iron-ore. From 30 to 40 feet of these upper shales and flags are seen in the valley of the Sandy Lick.

Down the Sandy Lick Creek, 2½ miles E. of Troy, the Ferriferous Limestone appears, thin and blue, with a sandstone roof. Twenty feet below it is the Clarion Coal-bed, 1½ feet thick. It occurs again in the road immediately below the Little Run, ascending the hill to Troy. Here it is 4 feet thick. The Clarion Coal, opened below it in several places, is 2 feet thick. The Kittanning Coal was not discovered above the limestone.

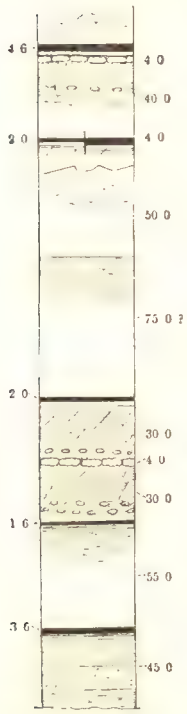


Fig. 436.—One mile below Troy.

One mile below Troy the following section (see Fig. 436) was obtained :—

Sandstone, *Freeport*, 50 feet, to the top of the hill. Shale and Sandstone, 75 feet. *Kittanning Coal*, 2 feet; Brown Shale, with compact oolite iron-ore, 30 feet. *Ferriferous Limestone*, 4 feet; Shale and Slate (ore in lower part), 30 feet. *Clarion Coal*, 14 inches. Shale, 55 feet. *Brookville Coal*, 3½ feet; Shale and Slate to bed of the creek, 45 feet. The Freeport Sandstone covers the country upon the road to Kittanning.

The *Lower Freeport Coal-Bed* is first met with capping the highest hills on the Red Bank Creek, 6 miles below Troy. It is opened at the Old Tavern, 4 or 5 miles farther towards Kittanning, as in the following section—(see Fig. 438) :—

Shale; *Upper Freeport Coal; Freeport Limestone;* Sandstone, 50 feet. *Lower Freeport Coal*, 4½ feet. Freeport Sandstone (a few pebbles), 50 to 60 feet; Shales, &c., 75 feet. *Kittanning Coal*, 2½ feet; Sandstone, flaggy, 45 to 50 feet; Dark Shales, 10 feet. *Ferriferous Limestone*, 6 feet; Shale, olive and yellow, 20 feet. *Clarion Coal*, in the bed of the creek.

These strata rise towards the fifth axis as we descend the Red Bank Creek. The Ferriferous Limestone is repeatedly exposed along the creek, and at a considerable height above the mouth of Leatherwood Creek.

The Lower Freeport Coal is opened on the hills half a mile S. of the tavern, about 175 feet above the creek; it is of a good quality, and 3 or 4 feet thick. Its roof is formed by 10 feet of brown shale: no limestone is visible.

The Lower Freeport Coal is well seen on a little run which enters the Red Bank 3½ miles below Smith's Tavern, and 2 miles S.E. of New Bethlehem. It is here, at Brown's, 10½ feet thick, the uppermost 8½ feet of the bed consisting of excellent cannel-coal, compact, and breaking out in pieces of considerable size, with a conchoidal fracture. Two feet of ordinary bituminous coal underlie the cannel coal, without graduation or interpolation, and this again rests upon black slate. Above the coal are 20 feet of soft brown shales, upon which are sandstones supposed to be members of the Mahoning Sandstone, above the Upper Freeport Coal. A similar coal-bank, supposed to be upon the same Lower Freeport Coal-bed, exists on Pine Creek (marked Beaver Creek on the State Map), 5 miles S.E. of this locality.

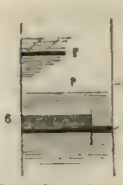


Fig. 437.—Brown's Cannel Coal.

A terrace, replete with springs, was supposed to mark the presence and position of the Upper Freeport Coal-bed, about 30 feet above the outcrop of the cannel coal.

Three miles E. of the Old Tavern we have alluded to on Red Bank Creek, there may be seen a bed of coal (Upper Freeport Coal), probably 4 feet thick, under which appears the Freeport Limestone. Gradually rising to a higher level, towards the N.E., the Upper Freeport Coal-bed appears to make its final outcrop in the centre of the basin, on the steep hills which bound the main stream of the Little Sandy Lick. At this line, the area occupied by this seam, and the Freeport Limestone under it, cannot be more than 2½ or 3 miles wide; but as the basin deepens S., this area gradually widens, and the outcrops separate, until the W. one arches over the fourth axis, 2 or 3 miles beyond where the latter has crossed the Mahoning Creek. The W. outcrop traverses the high hills which overlook the Red Bank Creek on its S. side, and then at the Olean Road takes a more South-easterly direction towards the Mahoning Creek.

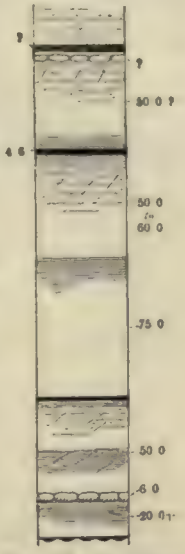


Fig. 438.—Red Bank, 6 miles below Troy.

At New Bethlehem, exposures of the rocks of the Clarion series are quite numerous. The *Clarion Coal-bed*, 5 feet thick, is opened 15 feet above water-level; roof, soft black shale, 8 feet exposed (see Fig. 439.) The Ferriferous Limestone, 4 feet exposed, hard, dark-blue, fossiliferous, is opened 25 or 30 feet above it; and still higher up, the Kittanning Coal-bed, 3 feet thick, good, with brown-shale covering. The Ferriferous Limestone is again seen at various places, 50 feet below the tops of the hills.

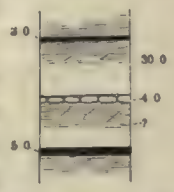


Fig. 439.—New Bethlehem.

The Ferriferous Limestone appears at Reynolds' and Schunk's Furnace, bearing its proper iron-ore. The limestone is grey, and about 6 feet thick. The ore overlies it, varying in thickness from a few inches to 3 feet. Below the limestone lies another bed of equally good ore, more regular, and averaging 9 inches in thickness. The ore is richest at the outcrop, where the carbonate of iron has been converted into the peroxide. No chert is seen.

Above the ore rest olive shales, perhaps 40 feet in thickness (Fig. 440), and over them the Kittanning Coal-bed, 30 inches thick, of poor quality, containing nodules of sulphuret of iron, and roofed by bituminous and brown shales. The hill is capped by the massive Freeport Sandstone.

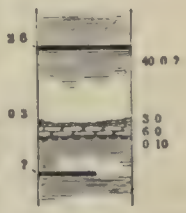


Fig. 440.—Reynolds' and Schunk's Furnace.

Descending the Red Bank, the Seral conglomerate and Tionesta Sandstone appear, but no coal is apparent between them; exposures are rare.

The Freeport Sandstone is the surface rock along a strip of country where the fifth axis runs S.W., after crossing the Red Bank Creek, 2 or 3 miles below the Furnace. This strip of country is in consequence sandy and barren. The following section (see Fig. 441) was made at the mouth of the Mahoning Creek:—

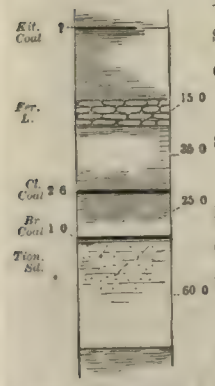


Fig. 441.—Mouth of Mahoning.

Ferriferous Limestone, 15 feet; Shale (ore), 35 feet. *Clarion Coal*, 2½ feet; Shale, &c., 20 feet. *Brookville Coal*, 1 foot. Tionesta Sandstone, massive, 60 feet; Shale, silicious, 25 feet; Olive bituminous Shale, 15 feet. *Tionesta Coal*, 1½ feet. Seral Conglomerate, massive, also shaly, 100 feet; Shale, sandy, partly carbonaceous, with seams of calcareous sandstone, from ¼ inch to 1 inch thick, 20 feet. Bituminous Shale, 3 inches; *Sharon Coal*, 2½ inches; Shale, sandy above, bituminous below, 3½ feet; *Coal*, 6 inches;

thin bituminous Slate, with some silicious layers, 11 feet ; *Coal*, 1½ inches ; Blue sandy Clay, 2 feet ; Slaty Sandstone, 25 to 30 feet, to the level of the Mahoning Creek.* These soon disappear beneath the water, with a dip of 5° S., 12° E.

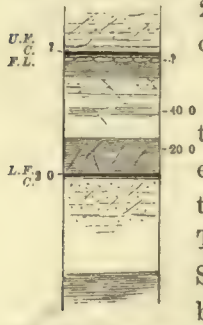


FIG. 442.—Two miles above mouth of Mahoning Creek.

None of the hills around are high enough to have the Lower Freeport Coal-bed, but both the Freeport Limestone and Upper Freeport Coal-bed are seen on Scrubgrass Creek, which enters the Mahoning 2 miles above its mouth (see Fig. 442). The coal is often so thinned away as to disappear, and let the Mahoning Sandstone rest upon Freeport Limestone. This is the case at the exposure on the North Branch of Pine Creek, where the Mahoning Sandstone is exposed, 60 feet thick, capping the hill. Here the lower shales of the interval between the two Freeport coal-beds are mostly dark brown and black, and contain layers of argillaceous iron-ore. There seems just here to be a local dip towards the W.

CHAPTER XX.

COUNTRY ON THE MAHONING AND COWANSHANNOCK WATERS, THIRD AND FOURTH BASINS, INDIANA AND ARMSTRONG COUNTIES.

As we follow the medial line of the Third Basin S. from Luthersburg, the Clarion strata sink with it, and outcrop on its margins ; they are exposed in the neighbourhood of Punxutawney, and on many of the tributaries of the Mahoning Creek. But in this region, as upon the Red Bank, the Lower Freeport Coal group, next above, is the principal one, for the Upper Freeport Coal is frequently absent, and the Elk Lick Coal seems to have dwindled again to insignificance.

At Punxutawney, the Mahoning Creek flows between slopes from 100 to 150 feet in height, abrupt on the S. bank, and gentle on the N., because the dip is S.E. The general upland level rises W. in obedience to the third axis.

At Punxutawney, the *Lower Freeport Coal-bed* underlies the village at a depth of from 20 to 40 feet. It makes its appearance upon the axis, which runs within a mile to the N.W. of the village. There the following section (see Fig. 443) was obtained :—

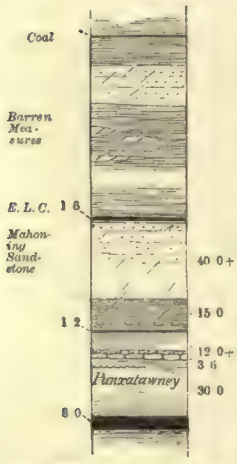


FIG. 443.—One mile W. and two miles S.W. of Punxutawney.

Sandstone ; variegated Shales and Sandstones. *Elk-Lick Coal*, 1½ feet ; Mahoning Sandstone, from 40 to 50 feet ; Shale, 15 feet. *Upper Freeport Coal*, with a band of fossiliferous calcareous Shale above it, 15 inches ; Dark Shales, 15 feet. *Freeport Limestone*, 3½ feet ; Shales, 30 feet.

The Lower Freeport Coal is 8 feet thick as it appears in the Little Run, 2 miles S.W. of Punxutawney ; the coal is solid and good, and dips with the run towards the S.E. At the surface the outcrop of this large bed was only 2 feet thick in one place, and 4 feet in another. At the head of the run it has also been opened.

The Freeport Limestone, half a fine-grained blue carbonate of lime, and half a carbonate of iron of similar aspect, makes its appearance upon the bluff, near the sawmill, running along about 15 feet above the water of the creek, and again in the mill-race above the village. It may be compared with the bed at Reynolds', on Sandy Lick Creek, and is doubtless the same. A band of black fossiliferous calcareous shale, found above it, is at least persistent enough to be found again down the Mahoning Creek, at Smicksburg.

* The lower portions of the section were taken from the exposures on the N. side of the stream ; the upper portions, from behind Templeton's Tavern.

The limestone rises as we descend the creek, and at Kinsel's is from 40 to 60 feet above the water-level. Above it, scattered thickly over the fields in patches, are to be seen many pieces of a honeycomb pure ore, of excellent quality and in great abundance; but the band does not appear in place. We may venture the assertion, that it is part of the semi-ferruginous Freeport limestone-bed itself, the highly ferriferous fragments of which have assumed this aspect in weathering. The fragments are spread over a long slope, at the head of which (perhaps 40 feet above the limestone) is a bench doubtless containing the Elk Lick or possibly the Upper Freeport Coal-bed. Beneath this supposed coal-bed is seen the outcrop of a conglomeritic sandstone (Mahoning?) Erratic blocks, broken from this formation, lie strewn upon all the bottoms of the Mahoning Creek in this neighbourhood; some of them are of great size, and quite angular. There lies a sandstone stratum upon the 6 feet of shale covering the Lower Freeport Coal (6 feet thick), 5 miles below Punxutawney, but of a wholly different character, being flaggy and homogeneous.

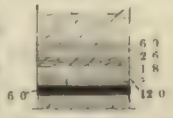


FIG. 444.—Mean's, Mahoning.

Here the Freeport Limestone is in two layers, the uppermost 20 inches thick, of good blue carbonate; then 2½ inches of bright-yellow clay; and underneath it, 12 inches of limestone is exposed, which may be thicker. Lying scattered about the quarry, as useless, are slabs of grey carbonate of iron, 1½ inches in thickness, and also of a shaly, silicious, hard, and heavy ferruginous semi-limestone stratum, recognisable also in the Smicksburg Section.

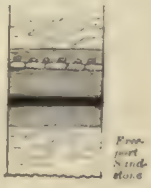


FIG. 445.— Freeport Limestone, 5 miles below Punxutawney.

At Templeton's, where the Lower Freeport Coal is only opened as a 3½-feet bed, with shale roof and slate floor, at the level of the creek, the Freeport Limestone, 10 or 12 feet above it, is a band 2½ feet thick, floored by shelly sandstone, looking like a decomposed ferruginous rock. At another opening it appears in three layers, thus:—

Pure black Limestone, 4 inches; Black Slate, 3 inches; Yellow Limestone, 4 inches; Clay, 3 inches; Limestone, 2 feet; Slate.—(See Fig. 446.)

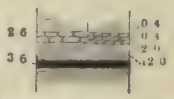


FIG. 446.—Frampton's.

At Kinter's Mill, where the third axis crosses the Mahoning Valley, the Freeport Limestone just reaches water-level, so rapidly has the axis declined from the neighbourhood of Punxutawney. Above it is a small bed, the Upper Freeport Coal; and high up towards the Barren Measures, which occupy all the high lands, are calcareous shales, with a 6-inch bed of coal upon them. These Barren Measures occupy the whole basin to the E. and S. of Punxutawney, yielding no workable coal, and no large bed of limestone, but displaying the conglomeritic Mahoning Sandstone everywhere as their base rock.

Near the head-waters of the Little Mahoning Creek, a limestone-bed is seen 20 feet below a coal-bed, both unidentified; at a level 60 feet lower, springs issue along a terrace, where they have deposited an extensive ore-bog at the village of Robertsville.

The limestone appears again at a place 2½ miles S.E. of Simpson's Mill, 4 miles W. of Robertsville. The strata dip W. after passing the mill; and at a place 2½ miles W. of it, a coal-bed, 2 feet 10 inches thick, is seen 4 feet above the water in the creek. A short distance below this, two other coal-exposures appear, one at a height of 50, the other of 30 or 35 feet above the water. The position of the uppermost (evidently the Upper Freeport Coal) seems to be signified by the presence of the limestone, at a level a little lower than its own, a short distance down the creek.

Two miles E. of Dill's Mill, 5 miles below Simpson's Mill, and at the crossing of the Indian Road, bluish-black, fossiliferous calcareous slates (the black limestone-strata of the Barren Measures) are seen on the N. side of the road, at a spring which issues 65 or 70 feet above the level of the creek. Descending the creek three-fourths of a mile, a limestone in two layers, separated by 1 foot of crumbly shale, is seen lying in the bed of the stream; and this continues to be visible at water-level to within 400 or 500 yards above Dill's Mill. Eighteen feet above the limestone there is a coal-bed (Upper Freeport Coal) 5 inches thick; the interval greenish and brownish shales, with some sandstone. Coal-roof, blue shale, 12 feet.—(See Fig. 447).

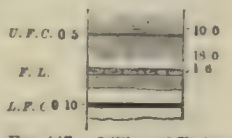


FIG. 447.—Dill's and Ewing's Mill, Mahoning Creek.

At Ewing's Mill, still farther down the creek, in a little run, is seen a bed of very pure carbonate of iron 18 inches thick, in layers of 4 and 5 inches thick, with concretions of silica, while masses and veins of apparently

pure carbonate of lime subdivide the ore. These limestone portions of the bed have a semi-crystalline structure, breaking into columns and cubes. Above it lie 10 feet of shale, and a thin coal (Upper Freeport ?). The massive debris of a conglomeritic sandstone (the Mahoning ?) fill the run and cover the slopes; while the great shale-formation of the Barren Measures is seen to form the high ground, traversing "the Hog-Back," and descending again to Kinter's Mill.

The Lower Freeport Coal-bed, 10 inches thick, appears in the race-way of Ewing's Mill, certainly not more than 20 feet below the limestone, which is 17 feet above the water-level below the mill; it is there capped by 5 inches of iron ore. On a little stream near by, the limestone again appears, and 16 or 17 feet above it is said to be an Upper Freeport Coal-bed, 10 inches thick. Fragments of a limestone stratum of the Barren Measures lie strewn upon the road near the mill, at an elevation of 80 or 90 feet above the water. These fragments are flat, 6 or 8 inches thick, and full of small clusters of crystallised carbonate of lime, and the same minute shells that are found in the Freeport Limestone.

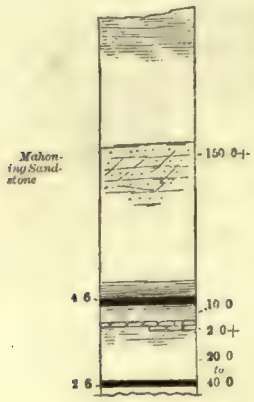


Fig. 448.—Smicksburg.

At Kinter's Mill the E. dip has raised the Freeport Limestone to a height of 40 or 50 feet above the stream. One hundred feet above the limestone, 2 miles S.W., appear the black fossiliferous limestone strata, over which is a coal-seam 4 inches thick.

Three-fourths of a mile above Smicksburg, the Freeport Limestone is about 18 feet above the creek, and apparently non-fossiliferous. At Smicksburg the Lower Freeport Coal, 2½ feet thick, lies in the bed of the creek at the Turnpike-crossing, and is cut by the village wells. It underlies the limestone from 20 to 40 feet. The limestone, with its fossils, stands at an elevation of 43 feet upon the N. hill-slopes.

About 10 feet above the limestone several old gangways have been driven in upon the Upper Freeport Coal, 4½ feet thick (see Fig. 448); above which are the fragments of the Mahoning Sandstone, quite conglomeritic. The land, back from the creek, is very high, but composed of Barren Measures.

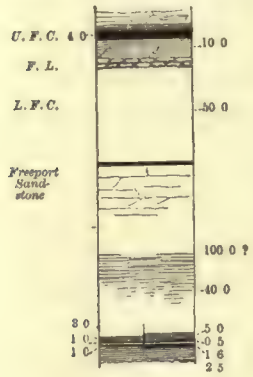


Fig. 449.

The Freeport (?) limestone appears 80 feet above the water, near the forks of the Great and Little Mahoning.

At the crossing of the Middletown Road, over the great Mahoning Creek, the strata begin to dip more steeply, and soon the Ferriferous Limestone and its overlying Kittanning Coal rise from the water.

The Upper Freeport Coal is seen N.E. of the salt-works, a little East of the road, 150 or 200 feet above the creek, the Freeport Limestone occurring at a little lower level opposite.

The fourth axis crosses somewhat below Glade Run, but so rapidly does it decline, like all the others, to the S.W., that on the Cowanshannock it does not lift the Ferriferous Limestone to water-level, although here that bed is at a considerable height in the hill-sides.

On Pine (marked Beaver) Run, above Smith's Sawmill, was obtained this section (see Fig. 450):—

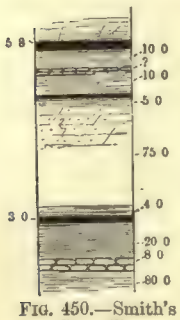


Fig. 450.—Smith's Sawmill.

Sandstone, 10 feet. *Upper Freeport Coal,* 5 feet 8 inches; Olive Shale, 10 feet. *Freeport Limestone;* Blue Shale, 10 feet. *Lower Freeport Coal;* Shale, 5 feet; Sandstone (Freeport), 75 feet; Black Slate, 4 feet. *Kittanning Coal,* 3 feet; Olive Shale, 20 feet. *Ferriferous Limestone,* 8 feet; 80 feet above the creek by estimation.

The Upper Freeport Coal-bed throws its W. outcrop across the Mahoning Creek, 5 or 6 miles above its confluence with the Alleghany.

The fourth axis is crossed by the outcrop of the Upper Freeport Coal-bed, 2 miles S.W. of the Mahoning. It crosses the Cowanshannock, 8 miles from Kittanning, and brings up in the bed of the stream both the Kittanning Coal-bed and the Ferriferous Limestone, while the Lower Freeport Coal-bed, 1½ feet thick, lies near the top of the hills.

Two miles W. of Rural Village, on a farm known as Smith's Tract, the Upper Freeport Coal-bed is 150 or

more feet above the creek, it is 4 feet thick, of good quality, but with a little sulphur. Ten feet below it is the Ferriferous Limestone, 6 feet thick. Fifty feet below the limestone is seen the Lower Freeport Coal, said to be 1½ feet thick. Upwards of 100 feet lower down, near the creek-level, is the Kittanning Coal-bed, thickness unknown. This locality is on the E. side of the fourth axis, and distant from it 2 or 2½ miles; dip S.E.

At Patterson's Mill the Kittanning Bed, covered by 40 feet of shales, reads thus :—

Bituminous Shale, 3 feet; *Coal* and Slate interleaved, vegetable impressions numerous, 12 inches; *Coal*, 12 inches (7 feet above level of water); Floor, black Slate.

Lower down it reads thus :—

Black Slate, 5 feet; *Coal*, 5 inches; Bituminous, pyritous slate, 18 inches; *Coal*, 15 inches; Slaty Coal, 14 inches.

CHAPTER XXI.

THIRD BASIN, IN INDIANA COUNTY.

THE country to be described in this chapter is traversed by the waters of Black Lick Creek and Crooked Creek, and is wild and unsettled toward the N.E. It is overspread almost everywhere by the rocks of the Barren Measures, the Fossiliferous Limestone of which makes its appearance about half a mile N.E. of Indiana Town, on the road to M'Kee's Mill. It is thinner than usual, and covered by red and variegated shales: it yields no good lime.

One of the coal-beds of the Freeport series, called Stuchel's Coal, has been opened upon M'Kee's Run, 4 miles from the town, half a mile above the grist-mill, and 10 feet above the level of the creek. It is thus :—

Coal, 22 inches; Greyish-black crumbly Shale, 8 to 10 inches; *Coal*, 4¼ feet; Clay and Shale. The roof is grey micaceous sandstone; dip N. 30° W.; it contains much sulphate of iron.

A bed, corresponding in position and character to Stuchel's, is opened on Hiram Thomas's land, 3 miles E. of Kellysburg, and measures between 5 and 6 feet in thickness. This same bed probably makes it appearance on Rayne's Run, a tributary of Crooked Creek; on the opposite bank its fragments of blue Freeport Limestone, at a higher elevation than that of the coal, dip rather steeply towards the W.

A bed similarly divided by a band of slate is found near the water-level on Crooked Creek, N.E. of Chambersburg. At this point a band of limestone lies 10 feet beneath the coal, but the beds have not been fully developed. In the vicinity of Marion, on the head-waters of Pine Run, a bed 5 feet thick is opened at several points. S. of this, on Buck Run, a branch of Two-Lick Creek, Messrs Chapman and O'Neal have opened a bed for their own use. The dip is W. into the Third Basin. In Green Township a bed 4 feet thick is opened by Mr Black on Dixon's Run, 1¼ miles S.E. of which a bed of the same thickness, known as Shedrich's, is underlaid by limestone. The latter is no doubt the Freeport Limestone overlaid by the Upper Freeport Coal. Descending Two-Lick Creek to a point 2½ miles above Young's Mills, we see a coal-bed 3 feet 8 inches thick, 23 feet above the creek. Below, and opposite, but at least 130 feet above the creek, is Allen's Coal-bed, about 3 feet thick.

Another bed, the roof of which is slate, with iron ore, is also about 3 feet thick; it is only 50 feet above the creek, at the sawmill. Upon the high land W. of these is seen a fossiliferous limestone stratum, 3 feet thick, over which from 10 to 15 feet is a black bituminous slate, with impressions of a Modiola; while to the N.E., at a level perhaps a little lower than the limestone, is seen a small coal-bed (see Fig. 451). The Modiola Limestone is seen 3 feet thick farther down, and half a mile to the right of the creek; and above it 12 or 15 feet there is a coal-bed said to be 2½ feet thick. The Freeport Limestone appears 10 or 15 feet above Two-Lick

Creek, at a point one mile above Young's Mills; at an equal distance above it is the Upper Freeport Coal-bed, but thin. A coal-seam, perhaps the Lower Freeport Coal, shows itself, 3½ feet thick (and said to have yet a lower member underneath, a stratum of slate), just above Young's Mills, 10 or 12 feet above the water: it enters the water 1½ miles below; and half a mile still lower down, a limestone is said to occur over it.

Fig. 451.—Two-Lick Creek.

Two miles below the forks of Two-Lick and Yellow creeks, in the bed of a little run to the left of the road, is a blue non-fossiliferous limestone; blue and black slates lie above it, and a thin 9-inch coal-bed. Sixty feet above these Barren Measure strata, a large Coal-bed is said to have been opened. Within a mile of Black Lick Creek, and to the N.E. of Two-Lick Creek, a 7-feet coal-bed, parted by bands of slate, has been opened. This is probably the Pittsburg Coal-bed. This Pittsburg Coal is seen on the W. side of the Two-Lick; half a mile N. of the Black-Lick Creek it is 7 feet thick. From 60 to 65 feet below the coal a highly fossiliferous limestone is seen outcropping E., the fossils being identical with those of the Freeport Limestone.

The green fossiliferous limestone strata are seen a little above the Forks, 35 or 40 feet above the level of the stream, reading thus:—

Argillaceous Limestone, studded with bivalves imperfectly preserved, 6 inches. Compact Limestone, with fewer fossils, 4 inches. Green, red, &c., Shales, in coloured bands, 10 to 12 inches thick. Green fossiliferous Limestone, 10 inches. Greenish Sandstone, 5 inches. Red Shale, 2 feet; Dark-blue Slate.

These strata are again seen 20 feet above the water in the following section, made in a little hollow 2½ miles from Campbell's Mill:—

Unknown to the top of the hill, 40 feet. Sandstone, 40 feet; Unknown, 20 feet; Sandstone, 17 feet. Red argillaceous Stratum; Sandstone, 4 feet; Slate and Shale, 10 to 15 feet; Unknown, 25 to 30 feet. Red argillaceous Shale, containing small bivalves, red argillaceous stratum, bluish in spots, 8 feet. Light green fossiliferous Limestone, 10 inches; 20 feet to the Creek-bed not exposed.

Nearly opposite this section some nodular hematitic ore, in very red shale, may be observed. The Pittsburg Coal-bed occurs at an elevation of 150 (?) feet. Half a mile E. of Gibson's Run, fragments of the non-fossiliferous limestone 3 feet thick outcrop, 60 feet beneath the Pittsburg Coal, and are visible at an elevation of 105 feet above the creek. Heavy slaty sandstone lies above; 50 feet below it are the variegated shales.

The Pittsburg Coal is seen on the W. side of the Indiana Road, and also a mile from Campbell's Mill, but no farther N. Near the mouth of the Black-Lick Creek the following section was obtained:—

Olive Slate, 20 feet. Blue Slate. Unknown, 15 feet. Calcareous Clay, 2½ feet. Red and Green Shales, 6 feet. Green Shale, 10 feet. Unknown, 25 feet. Green fosssiliferous Sandstone, 10 inches. Unknown, 10 feet. Red Shale, 3 feet; to the level of the creek, 54 feet. A slide has covered the hill-side only 20 feet above the water with fragments of the green fossiliferous limestone stratum.

Just at the forks of Two-Lick and Black-Lick creeks a coal is cut by the railroad; it is about 4 feet thick, and is underlaid by a thin band of limestone. The railroad also cuts a small seam 1 foot or 1½ feet thick S. of Smith's Station. On the hills in the neighbourhood the Pittsburg Bed is wrought.

Descending Crooked Creek, on the main Indiana Road, 1½ miles below the crossing, is McCallam's Coal-bank, on the Upper Freeport Coal-bed, 22 inches thick. Below it is the limestone in the bed of the creek; this is again seen 2½ miles down the stream, below which it is abundant at water-level. Four hundred yards down the creek, and near the water, a coal-bed 3½ feet thick is opened.

Below this point the Barren Measures compose all the land above water-level, keeping the coal-beds under and out of sight, to be mined hereafter only by shafts. The variegated shales approach water-level. At Shelocta Settlement, 1 mile from the county-line, the contrary (Easterly) dips commence, and bring up the coal-beds. There appears first, not far below Shelocta, the thin black fossiliferous stratum before spoken of, and

12 feet above it a highly-fossiliferous dark-blue limestone (37 feet above the water), covered by bluish-black crumbling shales.

The Upper Freeport Coal-bed comes out a mile farther down; it is nearly 3 feet thick where it is opened from 12 to 15 feet above the stream — roof, brown shale, 9 feet. The same bed appears a quarter of a mile W. of S.; it is 5 feet above the creek, for there is here a S. dip, and it is 3½ feet thick; roof, slate, several feet, then the bedded sandstone, 25 feet exposed.—(See Fig. 452.)

The Freeport Limestone is seen with its usually minute shells in the water a few hundred yards lower down, near the confluence of Plum Creek. It may be 9 feet below the Upper Freeport Coal.

On Plum Creek, half a mile above its mouth, near the turnpike, the Ferriferous Limestone is about 27 feet above the stream, thus—(See Fig. 452):—

Coal, 4 inches; Shale, 15 inches; *Limestone*, 14 inches; Shale, 2½ feet; Limestone, 4½ feet.

The run called Anderson's Run flows upon it as a floor for 2 miles, descending from the third axis from the E. Here 4 feet of it are exposed, and its few fossils are exhibited. The Upper Freeport Coal is probably from 6 to 10 feet above it, and is opened on the W. side of creek; it is 3 feet thick, and of excellent quality. Shale and thin sandstone underlie the coal. Two miles above the Forks, below Hill's Mills, is seen the outcrop of a 12-inch coal-bed, which, lying from 70 to 100 feet above the Freeport Limestone, is both the black fossiliferous, calcareous, bituminous stratum before spoken of, and the Elk-Lick Coal-bed. The Upper Freeport Coal-bed must here be under Plum Creek bottom. A limestone, full of fossils, is visible on the W. side of the Creek Road, in a little run 3½ miles above Hill's Mill. Similar strata to those below the mill are found 2 miles S.W. of Georgeville, on very high land over which the road from Plum Creek passes. The North Branch of Plum Creek flows in the Fourth Basin. The Upper Freeport Coal is seen 8 feet above it, a mile above its confluence with the other branch: it measures 3¼ feet: it is from 14 to 16 feet above the water a mile still higher up, but no limestone is visible beneath it.

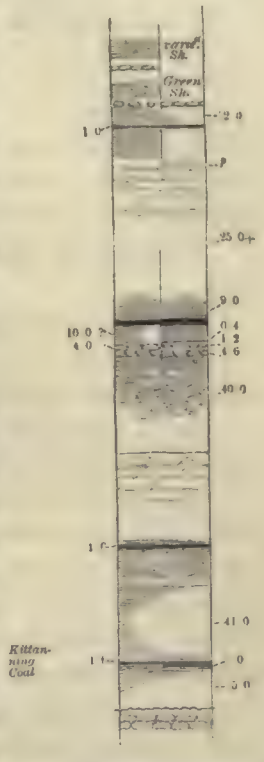


FIG. 452.—Compiled along Crooked and Plum Creek.

On the W. side, a short distance farther up, the coal is 35 feet above the stream, and 3 feet thick; below it is the Freeport Limestone, 15 feet above the water: its fragments strew the shore. Two miles higher, at Martin's Mill, the coal is 10 feet above the water-level, and is 3 feet thick.

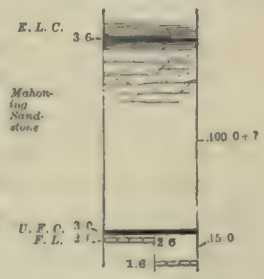


FIG. 453.—Crooked-Creek Bend.

The country around the head-waters of the two branches of Plum Creek is singularly destitute of loose surface-stones, because composed wholly of the soft slates and shales of the Middle and Upper Barren series.

In Young Township, bordering the county-line on the S.W., several beds of coal have been opened, and wrought to a very moderate extent for neighbourhood use. One of these, exceeding 4 feet in thickness, is opened at Patterson's, N. of the township line. The same bed is found at West Lebanon. One and a half miles S.W. of West Lebanon, coal is opened by Mr McMeans, and near the steam sawmill, W. of Blackleg's Creek, the Pittsburg Coal is developed as a bed of more than 11 feet thickness. In the neighbourhood of Jacksonville a coal-bed, 3 feet 6 inches thick, resting within 10 feet of a bed of limestone, is opened at various points.

The systematic description of the Conemaugh country will follow in a future chapter.

CHAPTER XXII.

FOURTH AND FIFTH BASINS—KITTANNING AND FREEPORT—CROOKED CREEK AND THE KISKIMINETAS.

On Crooked Creek, 2½ miles below Plum Creek, the Upper Freeport Coal is seen 12 feet above the creek, and 22 inches thick, as exposed: it soon dips under the stream. In the bend of Crooked Creek, the red and variegated shales of the Barren Measures, with nodules of hematitic ore, occur 45 feet above the stream, and fragments of green fossiliferous limestone 30 feet above it.

The Pittsburg Coal occurs upon the upland surface, three-quarters of a mile S.E. of this point on Crooked Creek.

The black limestone strata are seen rising W. under the greenish strata a fourth of a mile below the bend, and 20 feet above the creek. Over a dark-greenish slaty stratum, 10 inches thick, lies a nodular limestone, dark blue within, and full of fine bivalve molluscs; it is 5 inches thick: this, again, is capped by green shales.

Half a mile below this the Upper Freeport Coal rises to a height of 51 feet above the water-level, and is opened 3¼ feet thick: roof, bituminous shale, 1½ feet.

The *Ferriferous Limestone.*—This rock rises from the creek at Heath's; it is full of small bivalves (*Terebratula*, &c.), is flinty, thinly stratified, dark blue, and 5 feet thick. A quarry of a silicious sandstone, greenish-grey, and splitting into slabs, has been blasted in the strata 20 feet above the limestone. The slabs are used for tombstones in Middletown. These sandstones are largely developed in the bend of the creek below the next sawmill. A coal-bed, 1½ feet thick, is here from 20 to 25 feet above the water: the limestone is nowhere visible. A section made in the lofty sides of the valley at this place reads as follows—(see *ante*, Fig. 451):—

Mahoning massive Sandstone, 50 feet; *Upper Freeport Coal*, irregular, estimated to be 200 feet above the creek, 3 feet; Unknown, 15 feet. Freeport Limestone, 18 inches; Unknown, 10 feet. Sandstone and Shale, 40 feet; Freeport Sandstone, 50 feet. *Coal*, a few inches. Shale, 16 feet; Sandstone, 4 feet; Unknown, 41 feet.

Kittanning Coal (possibly the Ferriferous Coal), 1½ feet, unknown down to the creek; but at the Salt-works, a mile below, there follows:—

Ferriferous Limestone, here 22 feet above the creek, and full of fossils, 6 feet thick. The depth of the Salt Well is said to be 500 feet. A little to the E. of this appears to run the highest or axis line of the third anticlinal flexure. The Freeport Limestone, bearing its characteristic minute fossils, has fallen so far in its level by the time it has reached Pitt's Mill, 400 yards above the next Salt-works, that it is but 24 feet above the dam: it is semi-nodular, and 2 feet thick. The Upper Freeport Coal overlies it only 2½ feet, and is itself 3 feet thick. It is a thicker bed some hundred yards S.W., and the coal outcrop is 10 feet above it. A coal-bed is seen at a level 100 feet higher in the hill-side, and is (upon the supposition of the limestone being the Freeport Limestone) assigned to the horizon of the Elk-Lick Coal. Beneath it is seen a massive sandstone. If the limestone at the creek be the Ferriferous Limestone, this bed becomes the Lower Freeport Coal, supported by the Freeport Sandstone; but the fossils of the limestone seem decisive against that supposition.

At the lower Salt-works the fuel has been obtained from a gangway driven in upon a coal-bed 3 feet thick, and 60 feet above the stream.

The fourth anticlinal crosses Crooked Creek, half-way between this spot and its mouth, a mile above the bend through which the race-way is cut, but it does not bring the Clarion series to the day. At the mouth of the creek the Freeport Limestone is within 50 feet of the Alleghany River level.

At Kittanning the Ferriferous Limestone appears upon the opposite side of the river. Above the bridge it is about 70 feet above the river, and 12 feet of it are exposed. Upon it lies a stratum 5 or 6 inches thick, decomposing into a mottled iron-ore. The Kittanning Coal is 20 feet above the limestone. At the bridge these strata are much nearer the water-level. The Lower Freeport Coal, 1 foot thick, is seen on the Butler Road, which

ascends the hill from the bridge, 52 feet above the Kittanning Coal. The Freeport Sandstone here seems to be above instead of below the coal, and some doubt therefore rests upon the identity of this bed with that coal, suggesting that it may be the unnamed bed seen beneath the sandstone higher up the river. The true Lower Freeport Coal-bed seems to be represented here by the uppermost of two bituminous seams, varying from 4 feet to 6 inches in thickness higher up in the series. The strata (see Fig. 454), compiled from around Kittanning, indicate as follows, descending :—

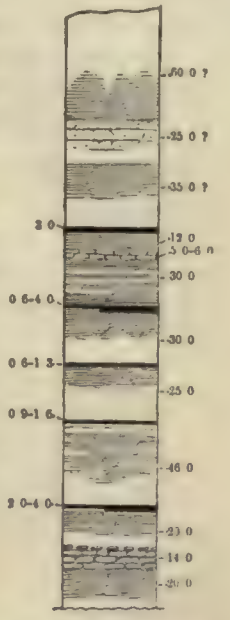


Fig. 454.—Kittanning.

Slaty Sandstone, 35 (?) feet; Red and variegated Shales, 15 (?) feet; Brown Shales and argillaceous sandstone, with nodules of iron ore and bands of arenaceous limestone, 45 feet. *Limestone*, blue, black, sandy, 12 inches. *Coal*, not always present, 6 to 9 inches. Olive Shales and slaty sandstones, 25 (?) feet; Blue Shales, 25 (?) feet. Slaty Sandstone, 60 (?) feet. Brown and blue Shales, 60 (?) feet. Slaty Sandstone, 25 (?) feet. Brown Shales, 25 (?) feet. *Upper Freeport Coal*, 3 feet. Blue compact Shale, 10 to 15 feet. *Freeport Limestone*, 5 to 6 feet. Shale and Sandstone, 30 feet. *Lower Freeport* (?) *Coal*, 4 feet, sometimes thinned away. Brown and black shales, 25 to 30 feet. *Coal*, 6 to 15 inches. Shales, 25 feet. *Coal*, 9 to 18 inches; Fire-clay, 6 feet. Sandstone (Freeport) and shale, 46 feet. *Kittanning Coal*, 2 to 4 feet; Fire-clay and shales, 25 feet. *Iron-ore; Ferriferous Limestone*, 12 to 14 feet.

Descending the hill opposite Kittanning, we have the following section :—

Friable brown Shale, 20 feet; Coarse grey Freeport Sandstone, layers contorted and broken, 40 feet. Soft brown and black Shales, containing an unnamed coal-bed 1 foot thick, 20 feet. *Coal*, 20 inches; Coarse blue Clay, 8 feet, passing downwards into brown shale, and then slaty sandstone, 40 feet. *Kittanning Coal*, 3 feet; Shale, 25 feet. Ferriferous Limestone, 15 feet; Shale, 20 feet; river.

In the little ravine below the town, the following imperfect section was partially levelled :—

Green Shale, 2 feet; Light-blue Shale, 2½ feet. *Upper Freeport Coal*, 5 feet; Unknown, 6 feet. Freeport Limestone in fragments; Unknown (Shale, &c.), 40 feet; Brownish-grey slaty Sandstone, 8½ feet; Blue and grey Shale (6 to 8 feet exposed), 25½ feet; *Coal*, 4 inches; Shale, brown, passing into sandstone, 5 feet; Grey Slate, 3 feet; Unknown (shale), 29 feet; Shale, 5 feet; Arenaceous Shale, 3½ feet; Sandstone, solid above, slaty below, 14 feet; Blue Slate, 3 feet; Bed of Sandstone, 4 to 6 inches thick, immediately upon the *Kittanning Coal*, 3 feet; Unknown, 24 feet to the road, and 15 feet more to the river, at low water.

The town of Kittanning is built upon the Ferriferous Limestone, which is of a grey or blue colour, not containing many fossils; it is from 14 to 16 feet thick. Its fragments cover the river-banks, until it sinks under water-level below the town. It is seen on Reynolds' farm, 1 mile N. of the town, where the Kittanning Coal also appears 20 feet above it.

Near the Court-house the Ferriferous Limestone has been quarried at the level of the town, and the buhr-stone ore stripped from it over a considerable area. Along the face of the hill behind the town the Kittanning Coal-bed has been opened at various points. At Mr Nulton's opening, N. of the Court-house, it measures 4 feet in thickness, and is divided by a thin slate about a foot from the top. Followed S., it declines in thickness to 2 feet or 2 feet 6 inches. Below the rolling-mill, where it has been opened in a ravine near the railroad, it proved to be 2 feet 10 inches thick. From this point it gradually sinks beneath the river-level. Below the bed of the river the limestone was cut in a well in the ravine.

The small coal-bed next over the Kittanning Seam, and the strata immediately adjacent, are well exposed by a cutting on the Alleghany Valley Railroad, one-third of a mile below the rolling-mill. The coal presents variable dimensions, fluctuating between 9 and 18 inches, and is divided in the middle by a thin band of slate. It is immediately underlaid by a band of impure, somewhat indurated, fire-clay, varying in thickness from 2 to 10 feet. Through this are disseminated nodules of rough iron-ore. Beneath the fire-clay is an irregularly-stratified mass of highly argillaceous micaceous sandstone. The natural colour of the rock is blue, though when weathered it assumes variegated tints, chiefly light olive-green and reddish-brown. It contains vaguely-marked vegetable

forms. Over the coal repose dark-blue shales, weathering rusty brown. These shales are 25 feet thick, and in some places curiously distorted. They become more compact and silicious towards the top, and a thin layer of bituminous shale and coaly matter may be seen interstratified with the mass—dip S.W. 2° to 3°.

The two small coals above mentioned are exposed in a ravine below Squire Buffington's mines, on the hill above the rolling-mill. Here they are 15 inches thick each. The Kittanning rolling-mill is supplied with coal by Squire Buffington, from a seam lying about 30 feet higher than the uppermost of the small coals. The bed, when regular, measures 4 feet in thickness, but in the mines it sometimes thins away to a mere streak. Over it 30 feet the Freeport Limestone has been proved nearly 6 feet thick; and 10 or 15 feet above this, the Upper Freeport Bed, measuring 3 feet, contains 2 feet 9 inches of available coal. The coal from all of these beds contains more or less sulphur. It is not easy to say with certainty which of the three coal-seams, between the upper limestone and the Kittanning Coal, represents the Lower Freeport Bed; nor is it here a matter of much practical importance. The strata rise North-westwards. At the Alleghany Furnace the Kittanning Coal-bed is 200 feet above water-level; whereas at the salt-works, 2 miles below it, it is but 60 feet above the stream. A slight undulation is suspected to pass from Scrubgrass Creek through the neighbourhood of the Alleghany Furnace, causing local N.W. dips; also on the North Branch of Pine Creek. The section made at this furnace, and expressed in Fig. 455, is as follows:—

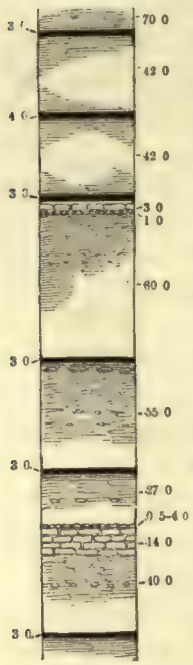


Fig. 455.—Alleghany Furnace.

Top of the hill, Shales, 70 feet. *Coal*, 3 feet. Unknown, probably Shales, 42 feet. *Elk-Lick Coal*, pure "coke-vein," 4 feet. Unknown, 42 feet. *Upper Freeport Coal*, 2½ feet. Freeport Limestone, nodular; *Iron ore*, 1 foot; Unknown strata, containing oolitic iron-ore, 80 feet. *Lower Freeport Coal*, 3 feet; Shale; Limestone in nodules; Brown and black Shale, with nodular ore, 55 feet; *Kittanning Coal*, 3 feet; Shale, with nodular ore, 27 feet; Ferriferous Limestone, overlaid by ore, from 30 to 40 inches thick, 14 feet; Brown and blue Shale, with argillaceous ore, 40 feet. *Clarion Coal*, impure, 3 feet, is 135 feet above the Alleghany River. The Tionesta or the Sharon Coal is said to have been found.

The Clarion Coal is in two bands, a fourth of a mile above the furnace. The Ferriferous Limestone is a greyish-blue rock, with a few Encrinites and other fossils. Upon it rests from 5 inches to 4 feet of iron ore, and occasionally 6 or 8 inches of chert interposed. The buhrstone or chert occurs in patches 8 or 10 yards square, and is of a yellowish-white colour and flinty substance. The lowest of the limestone layer, from 4 to 10 inches thick, is often so much of a carbonate of iron as to be useful as an iron ore. Six or more layers of nodular iron-ore run through the mass of shale below the limestone, and have been used at the furnace. The Tionesta Sandstone, and part at least of the Seral Conglomerate sandstone, are here above the water-level.

One mile N. of the furnace ranges the outcrop of the Upper Freeport Coal. This bed doubtless exists in the high land at the forks of the Franklin and Waterson's Ferry roads. Its main outcrop is seen on the Butler Turnpike, one and three-fourths of a mile from Kittanning, on very high land, whence it stretches in an undulating line S. to Buffalo Creek, crossing the Worthington and Freeport Road almost 3½ miles from Worthington. The dip towards Kittanning is from 3 to 5 degrees. Beyond the fifth axis, upon N.W. dips, the Elk-Lick Coal appears again, 12 miles N.W. of Nichol's Furnace, and at Sugar Creek Furnace, as already described. Two or three miles below Kittanning, on the E. side of the river, the Freeport Limestone is seen coming down to a much lower level. It is here about 10 feet thick. It is of a light-blue or dove colour, fine-grained, and homogeneous. On the opposite side of the river it is better exposed in a ravine three-fourths of a mile below the town, having beneath it a layer of iron ore varying in thickness from 6 inches to 1 foot, and similar to that seen under the same bed at Alleghany Furnace. A little farther down we have the following section:—

Shale; Upper Freeport Coal; Shale, 10 feet. Freeport Limestone, 6 feet; Shale and yellow Sandstone, with vegetable remains, 40 to 50 feet; Blue Shale in the river, 18 feet.

The Lower Freeport Coal was not seen, and probably does not belong to the above section. Half a mile lower down, the Upper Freeport Coal has been opened at about 70 feet above the river. This locality is 1½ miles above the mouth of Glade Run.

Back of the mill on Glade Run, on the Butler and Kittanning Turnpike, and a few feet above the level of the stream, is seen the *Lower Freeport Coal-bed*, from 3 to 3½ feet thick; roof, shale; floor, massive (Freeport?) sandstone.

The *Lower Freeport Coal*, which outcrops on the high land S. of Red Bank Creek, upon the Olean Road, is not seen in the hills on each side of the mouth of Mahoning Creek, these not being high enough for it; but it appears again 1½ miles distant down the Alleghany River, in the highest hill-tops, and outcrops on the road to Waterson's Ferry, 5½ or 6 miles from Kittanning, and again 2 miles N. of Worthington. It arches over the fifth axis, often lying upon this in patches immediately after passing Buffalo Creek; whereas the Upper Freeport Coal continues to outcrop on each side of the axis for 6 miles farther S.W. It may be seen 18 inches thick, on the hill-side over the Worthington Turnpike, upon the Western bank of Buffalo Creek. Here huge blocks of Freeport Sandstone beneath the coal-bed cover the slopes. Below the latter the Kittanning Coal-bed has been mined for the Buffalo furnace-engine, and yields 3½ feet of pure non-pyritous coal; roof and floor, ferriferous shales.

The Ferriferous Limestone is here 15 feet thick, blue and solid; above it is the ore-bed of the furnace, accompanied by very little buhrstone. The Tionesta Sandstone appears in the bed of the stream, with ferriferous shales above, and the Clarion Coal, here workable.

Three and a half miles S.E. of Buffalo Furnace, the Ferriferous Limestone and adjacent coals are brought up by the fifth axis, where it crosses Rough Run, half a mile above Haylett's mill, or 1½ miles above its mouth. Here the hills rise more than 200 feet from the water-level, and show the following section at their base:—

Shale; *Ferriferous Limestone*, 17 feet; Shale, 20 feet; *Clarion Coal*, 4½ feet; Shale, &c., 35 feet to water-level.

The Kittanning Coal is opened higher up on Long's Run, three-quarters of a mile N.E. of Haylett's mill. The dip is 5° a little S. of E.

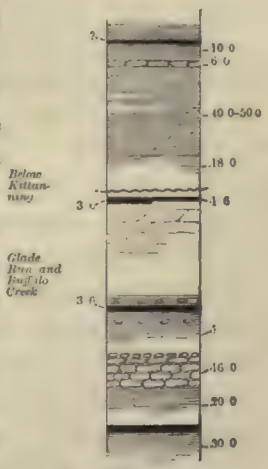


FIG. 456.—Shady Run.

Three or four miles S. of Worthington, a small run gives the following series:—

Slaty Sandstone, 10 feet exposed in layers, 30 inches thick; Soft black Shale (Upper Freeport?); *Coal*, 3 feet.

The establishment of Winfield Furnace has caused a tolerably full development of the strata upon the waters of Long and Rough Run. Besides the Clarion and Kittanning coal-beds, with the intervening strata embraced in our section, the Upper Freeport Coal, 3 feet thick, underlaid by its limestone, has been opened. From the associated fire-clay beneath this bed is derived the brown calcareous ore extensively used at Winfield Furnace for the smelting of iron. It is sometimes developed to a thickness of 4 feet, though its available thickness is not so great. We here find conditions closely analogous to those previously described at Brady's Bend.

At *Freeport*, one mile below the mouth of the Kiskiminetas, the following section was obtained (see Fig. 457), and illustrates what will hereafter be said of the line of the Alleghany River to Pittsburg:—

Green and grey micaceous Slate and Sandstone, somewhat calcareous, 36.1 feet; Blue Slate at top, brown Slate at bottom; Micaceous Sandstone; also dark-blue Calc Slates, containing a few stems of Encrinites.

Coal, 8 to 10 inches. Interval, 10 feet of green Slate, at bottom, 33 feet.

Coal, 18 inches, with few inches of rich slate above; Shale above, sandstone below, 15 feet; Sandstone, massive conglomerate at bottom, with nodular iron-ore in scattered balls or regular bands 2 to 4 inches thick, 23 feet.

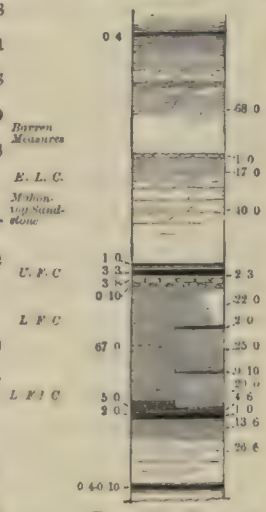


FIG. 457.—Freeport.

Coal, 4 inches; Roof, ferruginous Shale, Encrinites numerous, and bivalves; floor, blackish ferriferous Shale, passing into slaty sandstone, 12 feet; Shale, 9 feet; Sandstone Slate, 7 feet; Blue-black semi-bituminous crumbling Slate, 4 feet; Green argillaceous Slate, 26 feet; Calc Shale, 6 inches; Green Slate, 7 feet; Slate, 3 feet.

Limestone, Non-Fossiliferous, greyish blue, 1 foot; Grey and green Slate, 17 feet; Greenish-grey micaceous Sandstone, flaggy structure, 40 feet; Bituminous Shale, 1 foot; Bluish crumbling black Slate, 3 inches.

Upper Freeport Coal, 3.25 feet; Fire-clay and Shale, 2½ feet; Limestone, brecciated in aspect, greyish-*blue*, 3.8 feet; Nodular Limestone in shale, 10 inches; Olive Slates, 6.3 feet; Sandstone, 1 foot; Brown and olive Shales, 10.3 feet; Slaty sandstone, 1 foot; Brown Shales, 5 feet; Olive Shale, ferriferous, 4 feet; Brown Shale, 23 feet; Blue Slate, 12 feet.

Lower Freeport Bituminous Shale and Coal interlaid, 5½ feet; Shale, 2½ feet; Bituminous Shale, with carbonised stems, leaves, &c., 6 inches; *Coal*, 2 feet; Arenaceous Slate, ferriferous, and some sandstone, 13.5 feet; *Freeport Sandstone*, white, massive, lower part slaty, 26.5 feet.

Coal, 4 to 10 inches, divided by slate; Blue Slate, with fossil plants, 2½ feet. Interval 6 feet, to the river water-level.

It is probable that, if the hills had been a few feet higher, the Fossiliferous Limestone at water-level at Pittsburg would have been noticed in this section.

The lower part of the above section was taken opposite Freeport, above the ferry; the upper part a little higher up the river, near the old salt-works.

On Buffalo Creek, back of Freeport, two small coal-beds, not included in the section, have been ascertained to exist. The first of these, 2 feet thick, is 26 feet below the main upper coal; the second, 10 inches in thickness, is found 25 feet lower. Below this, about 20 feet, the bituminous-shale stratum of the section is now wrought for the extraction of oil. Of this material, which may properly be termed slaty cannel-coal, there is between 5 and 6 feet in two benches; the lower, sometimes subdivided, 4 feet 7 inches, the upper 1 or 2 feet in thickness. Immediately beneath this reposes a bed of dirty bituminous coal not exceeding 1½ feet thick. Both this slaty cannel stratum and the measures beneath are of exceedingly variable dimensions. The underlying sandstone, at one place 15 feet thick, at others exceeds 30; while in some wells sunk by Messrs Berg and Gillespie in pursuit of the cannel bed, they discovered in lieu thereof only ordinary black shale filled with vegetable impressions.

On the lands of Messrs Stuart and Dodd, upon the E. side of the river below the mouth of the Kiskiminetas, the slaty cannel-coal is separated from the bright bituminous bed by from 6 to 8 feet of slate. The cannel stratum averages 5 feet in thickness. The Freeport Sandstone beneath forms massive ledges along the railroad. On the E. side of the river the coals are at a higher level than on Buffalo Creek, owing to a local rise in the strata, but there can be no difficulty in identification.

A proximate analysis of Dodd's cannel-coal, by Dr Alter of Freeport, developed 34 per cent of volatile matter. From 22 lb. of the coal he obtained 33 ounces of crude oil, a gallon of which yielded one ounce of paraffine, besides coal-tar, and the lighter oils, benzole, &c.

On the Kiskiminetas, 1½ miles above its mouth, are fine exposures of the *Freeport Sandstone*, dipping both W. and N. (falsely bedded, perhaps?)

Two and a half miles above its mouth, the Upper Freeport Coal is about 108 feet above the canal, due E., and 25 feet higher than at Freeport.

At Ottuman's and Lochran's salt-works the Freeport Sandstone has passed the fourth axis, and descended below water-level, dipping S.E. This is 4 miles above the mouth of the stream. At the last-mentioned works the *Upper Freeport Coal* is 69 feet above the canal, all the strata below it being shales. At the canal-level are (Lower Freeport ?) black slates, from 4 to 5 feet thick. This mass of shales dips up river rapidly, and at the same time changes into sandstone beds still interstratified with shales.

At Leechburg, 5¼ miles above the mouth of the Kiskiminetas, above which is a gentle undulation of the strata, the following section of the rocks (see Fig. 458) was obtained at the quarries :—

Sandstone and Shale, 14 feet; Shale, 16 feet. *Upper Freeport Coal*, 4¼ feet, 63 feet above slack-water; Blue-black Shale, 14 inches; Light Shale, 6 inches; *Coal*, 4 inches; Light Shale, 14 inches; Iron Ore, 3 inches. *Freeport Limestone*, 1 foot; Calc Slate, shale, 3 feet; Shale and large chunks of Limestone, 4⅓ feet; *Limestone*,

32 inches; Shale, with calcareous nodules and flags, 5 feet; Calcareous Shales, 6 feet 8 inches; Shale, sandstone, &c., 3 feet; Sandstone, 1 foot; Shales, a little bituminous, 1 foot; Blue Ferriferous Shale, 7 feet; Shale and Sandstone, 6 feet. *Massive Freeport Sandstone*, 42 feet. *Lower Freeport Coal, interstratified with Slate*, 4 feet.

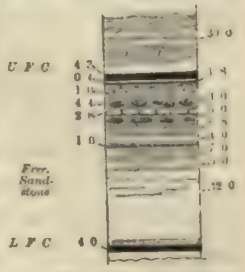


Fig. 458.—Leechburg.

The Freeport Sandstone, near the water's edge, is a fine quartzose conglomerate, containing vegetable impressions and pebbles of nodular carbonate of iron, of all sizes, and so numerous in places as to compose the whole mass of the rock for a thickness of 6, 8, or even 10 inches. A slip appears to combine with the original oblique bedding of the sandstone, to express to the eye of the spectator an unconformity of stratification at the upper limit of the sandstone; and upon its apparently upheaved edges rest the calcareous slates and coal above, as in the annexed woodcut (Fig. 459). Something similar may be observed elsewhere along the Kiskiminetas, as at a point 7 miles below Saltzburg.

Fig. 459.

At the salt-works, half a mile from Leechburg toward Warren, the *Upper Freeport Coal* is 62½ feet above slack-water, or 63½ feet above the level at Freeport. It is 3½ feet thick, covered by 16 feet of shale. It sinks to an altitude of 50 feet for the next 2 miles up the river, and is there 3 feet 3 inches thick, covered by 2 feet of black slate, and this by 8 feet of sandstone.

A fourth of a mile below this point the following section exhibits the coal at a much lower elevation :—

Shale, 6 feet; *Upper Freeport Coal*, 3 feet 3 inches; Shale, 22 inches; *Coal*, 7 inches; Shale, 3 feet. *Freeport Limestone, blue*, 2 feet; Soft Sandstone, 1 foot; Shale, 17 feet to bed of Pine Run, not much above slack-water.

This appears to be about on the middle line of the Fourth Basin. In the middle of the basin both coal and limestone seem thin and irregular. Approaching Warren within 3½ miles, the Lower Freeport Coal (?) is seen, measuring 2 feet 10 inches, good, with a lower slaty member 8 inches thick; roof, black slate, 2½ feet thick. Within 3 feet of its floor is the top of a solid sandstone stratum, 20 feet in thickness, extending down to water-level. Two miles and three-fourths below Warren, the following section (Fig. 460) was obtained :—

Fig. 460.—Below Warren.

Shale, &c.; Shale, 14 feet; Black Slate, 2 feet; *Upper Freeport Coal*, 2 feet 10 inches (61 feet above Lower Freeport Coal); Shale, &c., no exposures, 14 feet; Olive Ferriferous Shale and Sandstone, 20 to 25 feet; Sandstone, 18 feet; *Coal*, 1½ inches; Shale, a few inches; Sandstone, 5 feet. *Lower Freeport Coal*, bituminous slate, 2 feet, 10 feet above slack-water.

It is divided at a short distance from this point into two members by 1½ feet of shale. The coal is highly pyritous, and a little farther on, up the river, appears thus :—

Coal in thin flakes, 1½ inches; Grey Shale, 1½ inches; *Pyritous Coal*, 26 inches; Shale, 4 feet.

Below Warren the following section (Fig. 461) was levelled :—

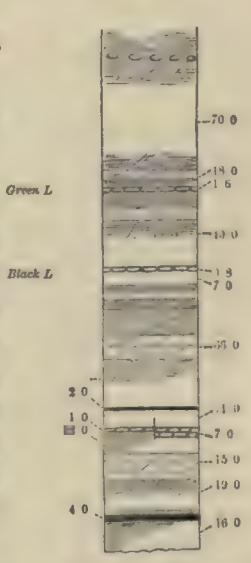


Fig. 461.—Warren.

Greenish and brown Sandstone and slate, hill-tops, 21 feet; Olive Slate, 18 feet; Interval, 67 feet; Terrace interval, 45 feet; Green Sandstone, 1½ feet; Olive-green Slates, 36 feet. *Limestone Fragments*, greyish-blue non-fossiliferous, from 12 to 18 inches in diameter; Olive Slates, 30 feet; Blue Slate, sometimes containing bivalve and flat spiral shells, resembling those of the "black limestone strata," 35 feet below; Yellow slaty Sandstone, 6 feet; Bright yellow Shale, 8½ feet; Green Shale, 4 feet. *Green Fossiliferous Argillaceous Limestone*, 19 inches; Clay and Shale, 11 feet; Light-coloured Shale, 5 feet; Blue Shale, 16 feet; Blue Slate, 6 feet; Blue fossiliferous Slate, 2 feet. *Dark-blue Limestone, nodular*, 4 inches; *Compact*, full of Encrinites, and univalve and bivalve shells, 4 inches; Blue ferriferous fossil Slates, 4 feet; Brown Sandstone, vegetable impressions, 3 feet; Shales, ferriferous above, bituminous below, almost coal for 6 inches, 7 feet; Slate, 17 feet; Sandstone, thin-bedded, 7 feet; Massive, 8 feet; Slaty, 4 feet; Shale, greenish, 12 feet; Olive, 11½ feet. *Upper Freeport Coal*, 2 feet at outcrop, 15 inches when driven in; interval, 11 feet. *Freeport Limestone, nodular*, 12 inches; Shale, 12 (?) feet; Sandstone, grey, 15½ feet; Brown Shale, 17 feet; Black Slate, 2 feet. *Lower Freeport Coal*, 4 feet; 16½ feet above bed of river.

Fragments of the so-called Freeport Limestone were burned by Mr Owen for lime, but without success. The dark-blue limestone above, roofed and floored with black slate, contains fossils easily obtained, and so characteristic of this part of the Barren Measures as to be highly important in defining the position of the Freeport Coal and limestone beds below. The stratum is a true geological landmark over a wide extent of Indiana and Armstrong counties. Here it occurs but 73½ feet above the *Upper Freeport Coal;* elsewhere the distance is increased. The interval above it also, up to the green limestone stratum, is less here than its average, being only 40 feet. The green limestone stratum is full of fossils, but has no great variety of species. Above this are barren exposures for 128 feet, and 151 feet more to the surface of the upland. In this last space some of the non-fossiliferous limestones below the Pittsburg Coal-bed should appear.

Three-fourths of a mile above Warren, the Freeport Limestone, 7½ feet exposed, is quarried on the N. side of the canal, 57 feet above water-level, pale in colour and highly silicious: the coal is not seen.

Below the Four-mile Slackwater Dam are several coal-openings, one of them upon the Kittanning Coal-bed, 3½ feet thick. The strata rise rapidly W. Just below the dam, and 3 miles above Warren, the following section (see Fig. 462) was obtained, in which, for the first time in ascending the Kiskiminetas, the Kittanning Coal appears:—

Hill-top, more than a hundred feet above, 8 feet of sandstone roofing the *Upper Freeport Coal* and *Freeport Limestone.* Interval hence downwards roughly estimated at 230 feet to the *Ferriferous Limestone,* 3½ feet exposed, elsewhere 7 feet; Brown Shale, 30 feet; Sandstone, 2 feet; Greenish Shale, 12 feet; Grey slaty Sandstone, 5 feet. *Iron Ore,* 5 inches; Shale, silicious, 7 inches. *Iron Ore,* 3 inches; Shale, 5 feet. *Iron Ore,* 2 inches; Shale, 1 foot; Argillaceous Sandstone, 10 inches. *Iron Ore, nodular,* 5 inches; Black Slate, 3 feet; Blue Shale, 7 feet. *Brookville* (?) *Coal,* 12 inches; Blue Shale, 4 feet; Black Slate, 18 inches, exposed at water-level.

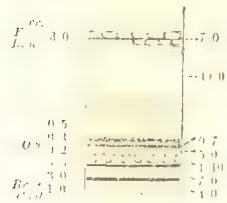


Fig. 462.—Three miles above Warren.

The third axis crosses perhaps a half-mile higher up the dam. The Ferriferous Limestone at Johnson's Salt-works is 55 feet above slack-water, 7 feet thick, and contains several species of fossil shells, a Terebratula, &c.

Just below the Salt-work Company's store, 2 miles above the dam, was obtained the following section (Fig. 463):—

From the top of the hill downwards, including 10 feet of shale just above the coal, 138 feet, estimated. *Elk-Lick* (?) *Coal,* 5 feet; Interval, 42 feet. Massive (Mahoning ?) Sandstone, 20 to 25 feet (bottom 115.7 feet above the Kittanning Coal). (*Freeport Limestone* not observed here, but a short distance up the river seen under Mahoning Sandstone, 3 feet thick.) Sandstone, thinly stratified, 77½ feet; Slate, &c., 6 feet; Shale, 29 feet. *Kittanning Coal,* 3 feet 9 inches; Shale (?) 18 feet; Sandstone, 7 feet; Shale, 8½ feet. *Ferriferous Limestone,* 6½ feet; Sandstone, 12 inches; *Iron Ore,* calcareous, fossiliferous, hard, 3 inches; Blue Shale, 10 feet. *Clarion Coal,* 1 foot; Blue Shale, 12 inches; Light-yellow Shale, 18 inches; *Coal,* 16 inches, 17 feet above water.

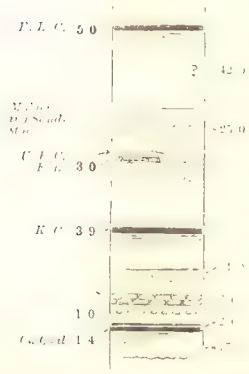


Fig. 463.—Four and a half miles above Warren.

It is remarkable that the lower coal-bed dips so steeply into the hill that it cannot be drained by the gangway, while the upper coal is not at all open to that inconvenience. This excess of dip characterises the lower strata in the hill.

The Ferriferous Limestone goes under the river-bed near the Salt Company's Store, the Kittanning Coal being at the level of the tow-path. The outcrop of the upper coal is observed rapidly descending E. up the river. Below the upper dam the Freeport Limestone is seen, 7 feet thick; and again, just below the dam and nearly on a level with the tow-path, where it is thin and nodular; the Upper Freeport Coal being absent or easily overlooked.

The middle line of the third sub-trough of the Third Basin crosses this upper slack-water (3 miles long) at about the middle of its length, and exhibits a very high series of rocks. The following section (Fig. 464) was made 3½ miles below Saltzburg:—

Soil, 7 feet; Grey Sandstone, slightly micaceous, 36½ feet. *Coal*, 12 inches; *Black Slate*, 2½ feet; Black Slate, 8 feet; Olive Shale, 10 feet. *Limestone, nodular*, 4 inches; Olive Slate, &c., under cover, 42 feet. *Coal*, 12 inches; *Clay*, 5 feet. *Limestone*, 14 inches; Shale, 2 feet. *Limestone*, 16 inches; Clay, variegated calcareous nodules, 5 feet. *Sandstone*, white, massive, weathering cellular in parts, 33 feet; Blue Slate, 10 feet; Grey Shale, 7 feet. *Pittsburg Coal and Slate*—(*Coal*, 30 inches; Black Shale, 3 inches; *Coal*, 12 inches; Grey Shale, 8 inches; *Coal*, 3 feet; Bituminous Shale, 2 inches; *Coal*, 3 feet); in all, 10 feet 2 inches; Clay, 2 feet; Sandy Slate, 15 feet; Micaceous Sandstone, greenish-grey, 4 feet; Light-coloured Shale, passing into an impure limestone, 15 inches, floored with calcareous clay—in all, 3½ feet interval. Shales, 7 feet; Greenish Shale, 12½ feet. Limestone, blue, non-fossiliferous, 1½ feet; Nodular Clay-bed, 2 feet; Greenish sandy Slate, 4½ feet; Nodular Clay, 2 feet; Green Slate, 3½ feet; Sandstone, 1 foot. Limestone Nodules in top of olive shales, 22½ feet; Green Slate, &c., calcareous nodules, 8 feet; Grey Slate, with bluff cleavage, 13½ feet; Grey and Purple Shale, 5 feet; Sandstone, 12 inches; Greenish Shale, 5 feet. Interval down to the water-level, 153½ feet.

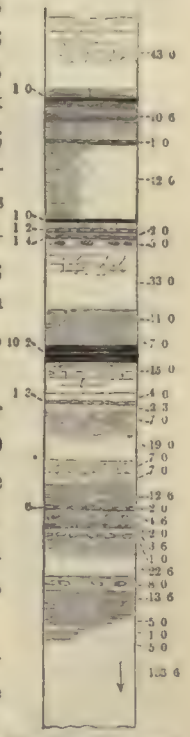


FIG. 464.—Three and a half miles below Saltzburg, on the Kiskiminetas.

Below this is the green Fossiliferous Limestone, as seen on the tow-path, passing under water-level at a point half a mile below. A small coal-bed underlies it at this place. At least 30 feet must be added to the last interval of 153½ feet, to bring the present section down to the green Fossiliferous Limestone, which will then lie about 350 feet below the Pittsburg Coal-bed. This remarkable stratum never seems to change its colour, and sometimes is nothing more than a mass of univalve shells cemented together by a fine mud. At Pittsburg it is seen 40 feet above the water, and 320 feet below the Pittsburg Coal-bed.

The Pittsburg Coal-bed, of this section, ranges Northward and Southward from the Kiskiminetas River, and towards Crooked Creek is underlaid by the same frosted-looking limestone seen at Pittsburg and elsewhere. The limestone stratum, 77 feet below the Pittsburg Coal, is a widely-persistent bed, as will hereafter be apparent; it is not quite *non-fossiliferous*, and has a brecciated aspect, although it is not fragmentary, but concretionary. It contains many of the minute fossils characteristic of the Freeport Limestone.

Towards Saltzburg the strata rise very slowly, the green Fossiliferous Limestone emerging from below the first lock at Saltzburg, where it consists of four bands, each between 1 and 2 feet thick, the whole measuring about 5 feet; and the representatives of the black Fossiliferous Limestone strata emerge in the first exposure above Saltzburg.

CHAPTER XXIII.

THIRD BASIN.—FIRST SUBDIVISION, ALONG THE CONEMAUGH: LOWER AND MIDDLE COAL-MEASURES.

THE first anticlinal axis crosses the Conemaugh a short distance below the spot where a small stream comes in from the S. below Blairsville. It barely elevates the Freeport Limestone to the level of the canal.

There are but two thin seams of coal exposed along the Conemaugh between Chestnut Ridge and the first sub-axis, belonging to the measures below the Pittsburg Seam. The lower is unimportant, the upper has been opened in but a few instances, as the country is supplied with fuel from the great Pittsburg Coal-bed above. The exposures along the river-banks from Blairsville to Chestnut Ridge are not good, and the difficulties attending the measurement of the strata are considerable. From the Pittsburg Seam down to the 60-feet interval actual measurements were made, but the thickness of the rocks below was only estimated.

Below Blairsville, the lower coal-beds are displayed: interrupted sections can there be made, but all the rocks exhibit a great tendency to variations of type from shale to sandstone, and *vice versâ*, within short distances, presenting perplexing difficulties to a general analysis of the contents of the basin.

Commencing with the lowest rock brought up by the first sub-axis below Blairsville, and proceeding down the river we have the following section (Fig. 465):—

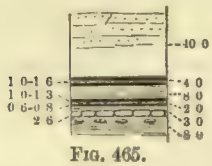


Fig. 465.

Blue Shale, 5 feet; Shales, 3 feet, with calcareous nodules; Irregular stratum of Limestone, 2½ feet; Blue Shale, 3 feet; Coal, from 6 to 8 inches; Dark-blue soft Shale, 2 feet; Coal, from 12 to 15 inches; Shale, 8 feet; Coal, from 12 to 18 inches; Blackish Shale with thin coal-seams, 4 feet. (This section is made 2 miles below Blairsville, in a cut in the canal.) Over all is a massive sandstone dipping gently with some undulations.

In the exposure, which is several hundred yards long, the rocks exhibit striking changes of character: thus, at one point the shale under the sandstone is 10 feet thick, but in a few rods becomes a sandstone, which rests immediately upon the coal. The shales between the coal-seams thicken and thin variously. At one place where this appearance presents itself, the coal seemingly terminates in the sandstone. Near the place where these disappear with a W. dip beneath the water-level, the massive sandstone, resting on the coal, changes wholly to shale for a thickness of 12 feet: the sandstone then presents a vertical wall, 40 or 50 feet thick, in coarse grey massive strata, with irregular lines of deposition along the canal.

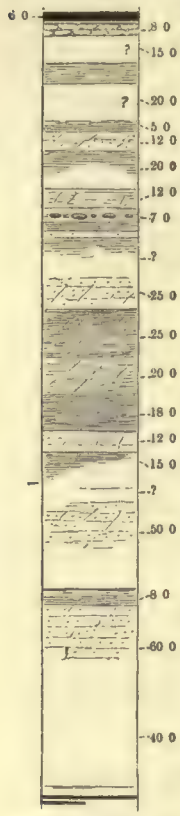


Fig. 466.—Opposite Blairsville.

This section finds no equivalent in the lower part of the section made above Blairsville; yet there is an interval of 30 feet in which it may find a place. The limestone may be the Freeport Limestone, as we find a locality a short distance up the Black Lick Creek where the Mahoning Sandstone appears, and over it grey slate 2 feet, and then slaty coal 18 inches. The dip is Westward.

There are frequent exposures of the middle series between the axis and Blairsville, of which the following is a compiled section (see Fig. 466); all the thicknesses were estimated by the eye, and collated as accurately as could be done.

It embraces nearly 400 feet of rocks, of which the upper one-third were observed opposite Blairsville; the middle third, 300 yards below the town, near the middle of the trough: the interval omitted must therefore be small.

Comparing this section with that made above Blairsville, nothing more than a general resemblance will be traced between them.

Second Subdivision.—The Conemaugh River takes a very irregular course across the second synclinal trough W. from Chestnut Ridge, affording frequent exposures. These present themselves in the order of the following section:—

Olive Shales, 80 feet; Black and brown Shales, 20 feet; Blue Shales, 50 feet; Olive Shales, 40 feet; Coal-bed, 18 inches, position unknown.

The summit of a high knob three-quarters of a mile below the mouth of Black Lick Creek gives this section:—

Yellow Shales, 13 feet; Red and blue Slates, with included calcareous nodules, 14 feet; Yellow Slates, silicious and shaly, 17 feet; Coarse grey Sandstone, strata much fissured, 16 feet; Dark olive Slates, 12 feet; Red Shale, 20 feet; Yellow sandy micaceous Slates, 30 feet—35 feet interval. Red Shale, 10 feet; Dark olive silicious Slate, 20 feet; Dark olive, bluish, sometimes fossiliferous Slates, 40 feet; Brownish-red and yellow Slates, 25 feet; Coarse grey Sandstone, with shale in irregular masses, 25 feet; Grey micaceous Sandstone, 200 yards below the former by the course of the river, 20 feet—interval, no exposures for 200 yards farther. Yellow, olive, and brown Shale with red layers, 30 feet; the Mahoning Sandstone; finally, the small coal-seams described in connection with the first sub-axis.

Lower rocks are exposed in the neighbourhood of Livermore at water-level. Three-quarters of a mile above Livermore there is a fine natural section of the olive shales (40 feet), and blue shales (50 feet), the latter falling into square gravel, and thin scales and splinters. A seeming displacement of the strata appears on two sides of a deep sharp cut. A micaceous sandstone caps the shales a quarter of a mile below Livermore, where the rocks are nearly horizontal; and still higher shales form a high wall for three-quarters of a mile lower down the river:

these are the 80 feet of olive shales at the top of the section, which continue exposed until near the tunnel, where a coarse sandstone band is also seen. From the W. end of the tunnel the river courses along the strike of the rocks, exposing no different strata for the distance of a mile, when it turns and cuts the second sub-axis, the olive slates forming high hills on each side.*

Thus there are estimated to be 500 feet of strata in vertical thickness above the thin coal-seams (or Upper Freeport Coal, as they no doubt are), with no indication of the Pittsburg Coal-bed, which does not make its appearance until we pursue the central line of this sub-basin Southward for several miles from the river, when it is found cropping out upon the highest hill-tops. The measures must therefore have received an enormous expansion (as described in the preliminary general description), compared with their condition in, and Eastward of, the second axis or Chestnut Ridge. That this expansion has taken place in the lower members of the Barren Measures, is apparent from the fact that the great mass of shales have no counterparts along the base of Chestnut Ridge.

The centre of the trough is in the neighbourhood of the tunnel, and there is seen a little Westward from the W. end of the tunnel, on a little run, and only elevated a few feet above the level of the river-bed, a band of black and somewhat concretionary limestone from 4 to 6 inches in thickness, containing fossils. The fossils, however, are much more abundant in a band of black ferruginous slate immediately below the limestone; they are mostly Bellerophons, with a large species of Ammonite, and a few other molluscs. Black bituminous slate is seen still lower in the bed of the river, and 15 or 20 feet of the same also overlies the limestone: green and mottled slate succeeds above this for 35 or 40 feet. These strata are doubtless the "Black Limestone layers" occurring at about their proper distance beneath the Pittsburg Coal, but having all the vastly-expanded shales of the lower Barren Measures beneath them.

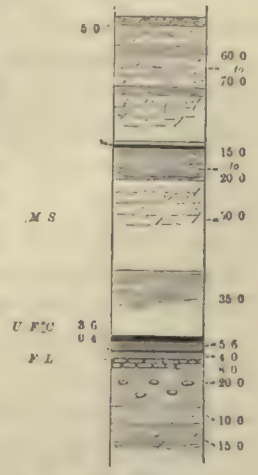


Fig. 467.—Saltzburg.

There is said to have been once discovered in the river-bed, below Livermore, a somewhat thick stratum of coal. If such has been the fact, the bed must be regarded as one of the small seams traversing the Barren Measures at various altitudes, and locally expanded in its thickness. Two miles from the W. end of the tunnel, the Saltzburg Coal-seam (Upper Freeport Coal) emerges with quite a steep Eastern dip from below the water. At Farelan's Salt-works, 400 yards below where it first emerges, it is 3 feet thick. At Mr Porter's it is 60 feet above the water-level, and begins to descend Westward: it dips beneath the water again a short distance below Mr Stewart's salt-well, where the river and canal sweep round the high bluff a mile and three-fourths above Saltzburg; the distance between its points of appearance and disappearance being between 3 and 4 miles.

A section of the rocks observed along the Conemaugh at and above the point where the Upper Freeport Coal disappears, is annexed (Fig. 467), and is compared with one obtained upon the Loyalhanna, also near the axis, and shortly to be described. Beginning from above it presents:—

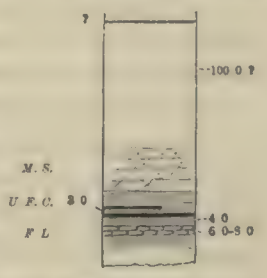


Fig. 468.—Loyalhanna.

Fossiliferous green Sandstone, 5 feet. (The debris of this rock occurs along the bank below, at the outcrop of the coal-seam below the canal-lock: it is in place N.W. of the lock). Sandstone, interstratified with compact shale, 60 or 70 feet. Bituminous Slate, or slaty coal, 4 to 6 inches, and 100 to 150 feet above the canal-level; Shale and Sandstone, 15 or 20 feet; Sandstone, 20 to 30 feet; by another section, 50 feet. This forms the high ledge of rocks above Saltzburg. Brown and olive shale, 35 feet. *Upper Freeport Coal*, 3 feet to 3 feet 8 inches; Black Shale, 1½ feet; Yellow Shale, 4 feet; *Coal*, 4 inches; Yellow and blue Shale, 4 feet. *Freeport Limestone* in irregular layers, and with

* This second axis is best located three-fourths of a mile below the Little Run, marked Elder's Run upon the State Map, he name of which, however, is now appropriated to another run flowing into the Conemaugh at Livermore, and between 4 and 5 miles below Blairsville.

some nodules of iron ore, 8 feet—in another place, only 1½ feet; Soft Shale, containing calcareous nodules, 20 feet; Grey micaceous Sandstone, 10 feet; Sandstone and yellow Shale, 15 feet.

In these exposures we find, in a distance of 200 yards, a complete conversion of a stratum of shale into massive sandstone, again into shale, and again into sandstone, thinly stratified and of quite a different colour. The Great (Mahoning) Sandstone, above the Upper Freeport Coal, forms a high wall or cliff along the river, below the mouth of the Loyalhanna. Along that creek, and also above its mouth, it forms the precipitous base of the hills along both sides of its valley, for a number of miles, as it winds its transverse course across the second sub-axis, through which it cuts as deeply as the Conemaugh.

The Upper Freeport Coal rises from the creek one-fourth of a mile below M'Guide's Mill, 2 miles up the creek. It is here 3 feet thick, and under it are 4 feet of black slate, supported by thin layers of limestone, and full of the most beautiful fossil-plants. It is 30 feet above the water 400 yards higher up the creek, and 45 feet above the water at an opening half a mile above the mill, and 3 or 3½ feet thick. One mile higher, it is 3 feet 8 inches thick, with bluish olive slate above. The Ferriferous Limestone is seen below, from 6 to 8 feet thick. A fourth of a mile still farther, the coal-bed sinks beneath water-level; that is, about 4 miles above the mouth of the creek.

At the bend of the creek, opposite Mr Bovard's house, there appears a seam of coal, a few inches thick, in the blue shales under the Mahoning Sandstone. Below Donolley's Mill the Mahoning Sandstone is a thinly-laminated micaceous sandstone of a grey colour, sometimes filling the bed of the stream with its debris.

Frequent exposures of the rocks of the Barren Measures are made along the Loyalhanna, as at New Alexandria, from a portion of the series, perhaps 250 feet beneath the Pittsburg Seam downwards, but consisting merely of a series of sandstones and shales of different textures and colours. Their aggregate thickness may be 250 feet. A thin coal-seam, perhaps 100 feet above the Mahoning Sandstone, was observed among them.

Half a mile from Snodgrass's Mill, the Pittsburg Seam makes its appearance at an elevation of 150 feet above the creek. Between this point and New Alexandria there are frequent exposures of the measures under the Pittsburg Coal, consisting of sandstones, slates, and shales, as on the W. side of the second sub-axis. Starting from a level, perhaps 250 feet below that of the Pittsburg Coal, we have a section composed of the following strata:—

Black and brown Shale, and over this micaceous sandstone, 15 feet; Yellowish-blue Limestone, 2 feet; Yellow Shale, with calcareous nodules, 3 feet; Blue and yellow Sandstone, in rough lumpy strata, mixed with shale; fissures filled with shale, containing fossils, 10 feet.

Grey Sandstone, 35 feet; Blue and red Shale, 12 feet; Impure yellowish Limestone, weathering light yellow, and falling into rough angular fragments; slaty layers, 6 feet; Blue and red Shale, 8 feet; Interval, 20 feet.

Grey rough Sandstone, 16 feet; Yellowish Slate and blue Shale, 15 feet; Dark-blue Slate, with silicious layers, thinly-laminated and micaceous, 35 feet; Soft olive, yellow, and blue Shale, 25 feet; Blue Slate; upper part Sandstone, lower part argillaceous, with nodules of carbonate of iron and carbonate of lime. *Coal*, 12 or 18 inches.

Blue Shale, full of calcareous and ferriferous nodules, 12 feet; Coarse brown Sandstone, near Craig's Mill, 25 feet.

Farther up the creek, and lower in the series than the rocks of this section, two thin coal-seams have been opened at Brady's Mill; they are the lowest rocks visible where the Loyalhanna crosses the first sub-axis above New Alexandria; their vertical depth below the Pittsburg Coal may be estimated at perhaps 450 feet. This returns us, by the way of the Loyalhanna, to the first sub-basin and the foot of Chestnut Ridge. This is so much deeper than the second sub-basin, that the Pittsburg Coal-bed reaches and passes under the bed of Loyalhanna Creek. The exposures along the creek flowing out of the gap of Chestnut Ridge towards the middle of the trough, or above Youngstown, exhibit the usual variable mass of sandstones and shales composing the Barren Measures, hardly to be identified at any two points, however close; and also some coal-beds, to be hereafter described.

CHAPTER XXIV.

1. LOWER ROCKS OF THE FIRST SUB-BASIN, OF THE THIRD BASIN, BETWEEN THE LOYALHANNA AND THE CONEMAUGH, ALONG THE BASE OF CHESTNUT RIDGE.

DENUDING agencies have acted with energy upon the outcrop of the Upper Barren Measures along the flank of Chestnut Ridge.

McGee's Run occupies the line of greatest denudation, having a ridge of sandstone strata containing the smaller lower coal-seams on the right, and another ridge, with the Pittsburg Coal-seam outcropping at its base, or on its side, to the left. The former generally exhibits a range of elevations blending at intervals with Chestnut Ridge, but standing out as bold knobs at all the transverse cuts or gaps. Sometimes it is rather a regular terrace than a distinct hill.

The flat valley of McGee's Run gradually narrows and heads up towards the S., as does that of the corresponding run flowing into the Loyalhanna. The central or Western ridge containing the Pittsburg Coal becomes higher, and exhibits less the effects of denudation. In the space between the heads of the two streams are frequent exposures of the Barren Measures (shales and sandstones). Some of these are persistent—as, for instance, the red and variegated shale-bands of the sections, and some of the larger sandstone strata. The lower coal-beds have been but little explored. A three-feet bed is opened at about a fourth of a mile from Ray's Mill; near this was seen a small coal-outcrop, with 20 feet of brownish shale above it. These are perhaps the Upper and Lower Freeport Coals. The notch at Ray's Mill is a gorge or cutting down into the Umbral red shales.

Approaching the Loyalhanna, no exposures of the lower coals are afforded that could suffice for an accurate section, until within a short distance of that stream where the hills are higher, and approach nearer to the Chestnut Ridge than on the Conemaugh.

Coal-Beds of Loyalhanna Creek.—The 5½-feet coal, the lowest in the series, is opened a short distance N. of Loyalhanna Creek, on the side of the ridge, and was judged to overlie the Seral conglomerate by perhaps 30 feet. The quality of the coal is good, though somewhat soft and a little slaty. Immediately upon the coal at this point reposes a coarse-grained white sandstone, 5 feet of which is exposed.

A few hundred yards from this opening towards the creek is an exposure of a 20-inch coal-seam, wrought, and yielding an excellent coal. The relative position of these two openings or beds was extremely difficult to determine. Two thin seams are exposed in the first depression at the base of the ridge, 1 mile N. of the creek.

The creek gives numerous good exposures of the rocks above these coal-beds, many of which are olive slates. A blank interval of 140 feet in the sequence, judging from surface fragments, consists of olive-coloured rocks, as does much of the space below the underlying 40-feet sandstone. But there does not seem ground for supposing the presence here of full equivalents of the enormous exposures of olive shales in the second sub-basin on the Conemaugh. As we go farther S., we find still fewer rocks of this colour. Exposures of the upper portions of the Barren Measures are rare. The 40-feet thick sandstone (Mahoning Sandstone) here forms quite high hills at the base of Chestnut Ridge. As we enter the gap, fine cliffs of the conglomerate are seen; then the Umbral red shales; and finally, at the axis, the Vespertine blue sandstone layers.

Coal-Beds of Loyalhanna at the First Sub-axis.—On the W. side of the First Basin along the Loyalhanna, the rocks of the Barren Measures are sandstones and shales, with a few calcareous layers, but no regular limestone bands. One of the lower coal-seams, 2½ feet thick, with bluish shale and sandstone over it, is exposed at a spot 1½ miles above Brady's Mill in the creek.

At Brady's Mill the rocks dip West (from the first sub-axis into the second sub-basin), and expose two coal-seams between 2 and 3 feet thick, and between them 25 feet of olive and grey slate, with silicious layers. Above the upper coal are yellow shale and coarse sandstone in thick strata. The coal, 1½ miles above Brady's Mill, is probably one of the two coal-beds opened half a mile from Craig's Mill.

2. LOWER ROCKS SOUTH OF THE LOYALHANNA, ALONG CHESTNUT RIDGE.

Denudation has acted along Nine-mile Run, as along McGee's Run, causing occasional exposures of the Barren Measure shales and sandstones. At none of the notches in the ridge are the lower coal-seams exposed for some distance to the S. of the Loyalhanna; Jacob's Creek is the first that cuts deep enough to bring their outcrops to the day. Of course, however, their E. outcrops run continuously among the sandstones high up Chestnut Ridge.

A similar ridge to that before described ranges along the W. side of the valley of the run, with the outcrop of the Pittsburg Seam along its base. The valley narrows in like manner as it heads up S., and the W. hills, gradually approaching Chestnut Ridge, finally form spurs or transverse elevations connecting it with the central height of the trough.

Between the waters of the Loyalhanna and those of Jacob's Creek, one branch of the Big Sewickly takes its rise near the Chestnut Ridge, being separated from the main creek, and continuing so as far as Jacob's Creek, always having the Pittsburg Coal outcrop on the W. side of the continuous depression.

Coal-Beds on the Big Sewickly, First Sub-basin and Axis.—Sewickly Creek, at its head, affords but few exposures of the E. outcrop of the lower coal-beds and middle Barren Measures. Along its course, through the first sub-axis in the East-dipping rocks, are some fine exposures of sandstone; a thin coal-seam also appears near the middle of the series.

The coal-bed (Upper Freeport Coal), from 6 to 4 feet thick, rises from the water-level to cross the first sub-axis for a distance of 4½ or 5 miles from Chestnut Ridge, at Roof's lower mill. Here there are exposed with the coal 15 feet of micaceous sandstone, and some layers of blackish slate. The coal is 4 feet thick, and upon it lies a coarse sandstone. This coal-bed supplies with fuel all the salt-wells along the stream, and is no doubt the same with that which supplies the salt-works of the Conemaugh. Its coal is rich, solid, and free from iron and slate impurities, though it occasionally shows a thin seam or two of interstratified slate. If this be the Upper Freeport Coal, it may appear strange that the limestone beneath it, so largely developed on the Conemaugh, is not here found.

The Sewickly Valley holds its course for several miles along the anticlinal axis, winding from side to side of the arch described by the Upper Freeport Coal-bed, and allowing numerous gangways to be driven into it. The greatest elevation of its arch from the water-level is about 75 feet, and its distance along water-level is not above 1½ miles. At Irvin's salt-well, on the E. side of the creek, it yields 4 feet of good coal; and here there is so great an evolution of inflammable gas from the swampy spot in which the well was sunk, that the gas has been caught and used as fuel beneath the boilers. Below this, at the salt-well at the forks of the creek, the coal-bed is from 3½ to 5 feet in thickness, exhibiting great irregularities and disturbances. At one point of its outcrop it is wrinkled, and is but a few feet above water-level. A few hundred yards W. of this, there is a coal-opening much higher in the hill-side, which may possibly be another seam; if so, it would be the Elk-Lick Coal, as that is its proper position, supposing the assumption to be correct that these various openings are on the Upper Freeport Coal-bed. It is remarkable that no trace of such a higher bed of Elk-Lick Coal has been remarked elsewhere along the stream; these may therefore be merely an upthrow or local flexure of the coal-bed.

At the Mammoth Salt-works the bed is from 3½ to 4 feet in thickness, with sandstone on the coal; while at the mill, a short distance below this, it is 3 feet thick, with slate and sandstone above the coal. At Painter's salt-well, and at the crest of the axis, the bed is 72 feet above water-level, and 3 feet thick. Here there is seen a thin seam 52 feet beneath it, the interval being a coarse-grained thickly-stratified sandstone. At this Salt-well the evolution of gas is very great, and is employed as before stated. Here the hills are very high, and exhibit continuous outcroppings of the Barren Measures. At their base is the massive sandstone rock beneath the Upper Freeport Coal.

At the salt-well, one mile below the last, the bed, with thin slate interlayers, is only 2½ feet thick, thinning

locally when followed into the hill. It is here 20 feet above the water, dipping W. Where opened at the salt-furnace opposite, it was not quite 2 feet thick. Openings up the hill-side to a great height above this bed, made in search of better ones, have developed some dark-coloured shales and two or three thin coal-seams.

The bed has been repeatedly opened with a gentle Eastern dip, perhaps three-quarters of a mile S.E. from the openings last mentioned, and found to be from 3½ to 5 feet thick, with sandstone roof.

Half a mile S.W. of this again, and on the opposite side of the high hill near Painter and Mitchell's lower well, this very irregular coal-bed exhibits the remarkable change of structure shown in the woodcut (Fig. 469), and that in the short distance of 300 yards, being at one place a single bed 3 feet thick, and at the other a double bed, divided by a layer of shale and sandstone, and each subdivision 3 feet thick. Farther on, in the same bank, a crush (section *a*) is visible: the upper bed is 3 feet thick; the two being separated by coarse sandstone.

A few yards from this we have *b*, the upper bed running out from 2 feet to nothing; and the undermost bed varying from 6 inches to 1 foot; *both shale and sandstone intervening.*

At another place, *c*, in the same opening we have the upper bed from 2½ feet to 5 inches thick, and the under one, 3 feet thick; with from 15 inches to 2 feet of sandstone intervening. A few rods off the whole bed has but 3 feet of coal; at another place it has 9 feet, with a few slate interlayers; these 9 feet shortly thin out to 1 foot. Some of the openings have been abandoned, the coal thinning out altogether. The roof shows numerous lumps and wrinkles, and is a confusedly deposited sandstone mixed with flakes of coal; stems of plants cross each other in all directions. The coal itself is highly bituminous, of a pure black colour, and separated into prisms. A boring, 300 yards from the openings last described, went down 100 feet, and touched no coal; whereas, had this bed, of which we are treating, proved at all consistent, it should have been struck by the boring 40 feet below the surface.

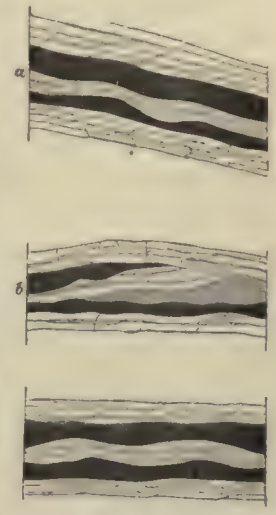


Fig. 469.

At Painter and Mitchell's lower salt-well, the E. bank of the Sewickly is 70 feet in height, being a deep escarpment of sandstones and shales; but no coal appears at the proper point—that is, 40 feet above the water—although it is wrought in the same strata only 70 yards to the E. To carry it below the creek-level an angle of 50° would be required, and that where the strata are almost horizontal; only a counter-dip of 45° could have projected its outcrop above the bank. The boring, 100 feet deep, also intervenes. The coal has therefore disappeared from this locality.

The Sewickly Creek flows along the axis for 1½ miles farther, and then W. across the second subdivision of the Third Basin. Mr Hurst's well is next in order to Painter and Mitchell's lower well, and perhaps three-fourths of a mile below it. The Upper Freeport Coal has not here been discovered in its proper position; coal is obtained from down the creek, where it sweeps to the W. Here it is exposed on the N. side of the creek bank, 4 feet in thickness, with a sandstone roof: the sandstone is coarse-grained, and full of vegetable impressions. The floor of the coal is a hard blue silicious slate. Old openings farther down the creek exhibit similar sections, the sandstone everywhere rolled, wrinkled, and confused.

At the bend of the stream is Harrol's coal-bank and salt-well, the latter 440 feet deep: a neighbouring well is 658 feet deep. The coal-seam is here from 4½ to 6 feet thick, subdivided by a thin band of blue slate at 18 inches from the floor. The top is sandstone, the floor hard silicious slate; the same character is found at Hurst's opening, 350 yards farther W. At D. Wortz's well, 400 yards farther on, the coal disappears beneath the creek. The sandstone often exhibits a thickness of 50 feet.

At Thompson, Turner, & Co.'s well, 1 mile S.E. of the creek at its bend, and 1 mile N. of the Mount Pleasant Turnpike, the bed averages 5 feet, but varies to 6½ feet. It contains here much sulphuret of iron, and has above it, as usual, coarse-grained irregularly-stratified sandstone, full of stems and leaves.

The following section of rocks intersected in boring the salt-well was kindly furnished by one of the proprietors; it commences at the surface of the ground, 25 feet below the coal-opening:—

Dark Slate, 39 feet; Sandstone, 42 feet; Light Slate, 24 feet. *Coal*, 3½ feet; Sandstone, 17 feet. Dark Slate, 48 feet; Sandstone, 19 feet. Soft Shale, 66 feet; Sandstone, 27 feet. *Slate* and *Coal*, 15 feet. Then "the Eighty-feet Rock" of the borers, a massive Sandstone, perhaps the Seral conglomerate, 112 feet. Black Slate, 16 feet. Red Slate, 50 feet. Sandstone to salt-water, 180 feet.

The 3½-feet Coal-bed is opened at other places between the Sewickly Creek and the Mount Pleasant Turnpike. It is 4½ feet thick at Hunter's old well, 10 feet above the level of the run; a band of pyritous slate runs through it 15 inches above the hard blue slate floor. At the turnpike, 5½ miles from Mount Pleasant, at the level of the run, the bed is 4½ feet thick, dipping gently E. The Great Mahoning Sandstone rests immediately on the coal. A thin slate-seam runs here also 18 inches above the floor. This is the most South-westerly exposure of the bed on the Sewickly waters: it appears again on Jacob's Creek.

The Sewickly runs hence W., exposing the whole series of the Barren Measures. Two very thin coal-seams occur in the series, dipping gently W. This gentle Westerly dip does not give place to an Easterly dip as we descend the creek, on account of the dying-out of the second sub-axis about 2 miles before it would have crossed the Sewickly. In consequence of this, a wide extent of country is here overspread by the Barren Measures; the Upper Freeport Coal being under water-level, and no dips being strong enough to bring it above the Pittsburg Coal. The terminus of the axis is marked by a few high knobs, but does not present so broken an aspect as does the face of the surrounding country; it has seemingly been more abraded by denuding forces. The hills slope gradually along this line to the rather wide depression or valley of the creek; while E. and S. of the creek, and also W., in the range of the Pittsburg Coal-bed, they rise more abruptly, and are higher. It is about 10 miles in a straight line from Chestnut Ridge to a high knob on the termination of this second sub-axis; and W. of this, to the point where the E. outcrop of the Pittsburg Seam crosses the Sewickly, it may be 2½ miles.

From the forks of the Robstown Road (5½ miles from Mount Pleasant), where the Upper Freeport Coal disappears in the run, as has been described, there are numerous exposures of the Barren Measures along the Robstown Road. Farther W., the red shales in the middle of the group frequently appear, though they were not seen along Sewickly Creek. A few small smut-lines are the only indications of the presence of coal, and these can be the outcrops of but very small beds. The Pittsburg Bed finally appears, and crosses the road a few miles W. of the forks.

3.—THIRD BASIN, FIRST SUBDIVISION, ALONG JACOB'S CREEK.

Jacob's Creek makes an irregular gap or notch in Chestnut Ridge, only deep enough to expose the silicious limestone strata at the base of the Umbral red-shale formation. Such exposures are seen at the arch of the axis a mile or two from the old furnace. Where the rocks begin to incline to the E. is an exposure of a few feet of soft ash-coloured shales; over these is a soft grey argillaceous limestone, full of fossils, 10 feet; over this, red shales, 12 feet; over these, grey micaceous sandstone, 20 feet. Supposing this to be the Seral conglomerate, search was made in the shales beneath for ore, but, with the exception of a few small nodules scattered through the shale, none was visible. It is probably to be found higher in the series. Farther down the Big Branch, abundant evidence of the presence of the Seral conglomerate is afforded by its fragments and exposures.

Upon a neighbouring head-branch of Jacob's Creek there is exposed a coarse-grained thickly-stratified sandstone about 60 feet in thickness; upon this are olive slates and blackish shales, with a coal-seam a few inches thick, among them; upon these lie blackish and olive shales, with sandstone interlayers, thickness unknown; over these, yellow shales, and a pure blue limestone stratum, 2½ or 3 feet thick. This mass of shales is about 20 feet in vertical thickness. Upon the limestone lie olive shales, 8 feet thick; then micaceous sandstone, 20 feet; then olive and yellow silicious slates, 30 feet.

For a space there are no exposures, and then occurs a coal-bed, 4 feet thick, of good soft coal, but containing sulphuret of iron in some quantity. Upon it lie dark olive shales, in some parts nearly black, and some-

times quite silicious, 65 feet exposed. We supposed this seam to be the 4-feet seam of Sewickly Creek, but remarked the striking absence of the Mahoning Sandstone above, and other irregularities consequent upon such an identification. A comparison with the section in Thompson, Turner, & Co.'s salt-well on the Sewickly, presented at the top of page 606, will guide us in assigning it its true position in the series as the Brookville (or Clarion) Coal-bed.

From this exposure the stream runs some distance along the strike of the rocks, but cuts them again across the dip a little above Lobinger's upper mill, exposing for three-fourths of a mile the sandstones and shales above the coal just described.

At the mill, another coal-bed, 4 feet thick, has been discovered near the mouth of a well sunk through it, and introduced into the section above. This is doubtless the Upper Freeport Coal of the salt-works.

A section was made past Lobinger's lower mill, crossing the outcrops of the lower coal-beds, and the outcrop of the Great Pittsburg Coal-bed, along the side of the central ridge of the basin. The following coal-beds were discovered in the side of the hills, and their distances asunder measured :—

First, Coal (Upper Freeport Coal), 3 feet ; above it, yellow Shale ; below it, at an interval of 43 feet, in which no rocks appeared in place, Coal, 3 feet ; below this, after another interval of concealed rocks of 136 feet, a third Coal-bed, 1 foot thick ; over it, coarse Sandstone, 12 feet exposed ; under it, blue and yellow Shales, with micaceous sandstone, 20 feet exposed.

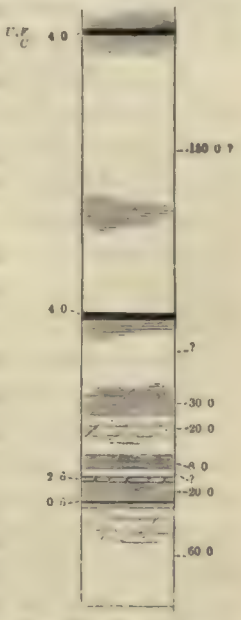


FIG. 470.—Jacob's Creek.

The uppermost of these seams exhibits a soft rich coal, separating into vertical prisms, and containing sulphuret of iron. It is divided by a thin slate, 1 foot from the floor, as seen in all the openings upon this bed along the Sewickly Creek. Its outcrop can be traced along the ridge to the E. of this locality. Above it, after an interval, is a small exposure of micaceous sandstone, and over this again the large sandstone stratum which forms the high rocks or spurs descending from Chestnut Ridge, between the head-runs of the creek. The space above this seam appears to be principally sandstone, interstratified with some shale. This is seen below the lower mill, on the South-facing point of the hill. The exposure is as follows :—

Sandstone, in thick coarse strata, 30 feet ; under this, olive and yellow, chiefly silicious Slates, 30 feet ; Micaceous Sandstone, 25 feet ; Olive, yellow, and blackish Slates, 20 feet ; Coal, brittle and hard, 14 inches ; Yellow Shale to the water-level.

Below the lower mill on the W., and higher in the series, is a sandstone stratum 50 feet thick, and under it a *coal-seam*, 6 inches thick, resting upon olive shales. Tracing the sandstone down the creek, a yellow slate, perhaps 20 feet in thickness, is seen to rest upon its top surface, and upon that a *coal-seam*, 3 feet thick, over which is a covering of yellow slate.

Thus we see that upon Jacob's Creek there are six coal-seams, from 6 inches to 3 feet thick, within a vertical section of perhaps 350 feet. If equal advantages for observation were everywhere afforded, no doubt similar results would be attainable along the whole flank of Chestnut Ridge. The uppermost 3-feet thick coal may be the Elk-Lick Coal-bed, or a locally enlarged exhibition of one of the small Barren-Measure coals. The Upper Freeport Coal has been worked by Mr Lobinger here, and also on Grass-Lick Run. The 3-feet coal-bed below it had there yielded 4 feet of coal.

Lower down the creek, exposures of the Barren Measures are numerous and unimportant, being chiefly of micaceous fine and coarse-grained sandstone and yellow slates. There is one exposure of the red-shale band of considerable thickness. At Mr A. Robinson's sawmill are seen a few thin strata of fossiliferous limestone enclosed in yellow slates. Still farther down the creek, and higher in the series, are found nodules of iron ore and of limestone in yellow shale. As we approach the part of the creek where the Pittsburg Seam is exposed, the dips become gentler, and the valley spreads as a wide flat, with low hills on either side. The creek flows along the synclinal trough, until within 3 miles of the Youghiogheny River, where it turns suddenly to the W., at

Strickler's mill, and traverses the first sub-axis. Almost its whole course is therefore in the Barren Measures; the Pittsburg Coal-seam nowhere descends to the water-level. Half a mile below the "Chain Bridge" it is 60 feet above the water; at Wade and Fullerton's mill, and Stouffer's mill, it is 80 feet.

High in the Barren Measures, and not more than 90 feet beneath the Pittsburg Coal, there is to be seen at the Jacob's Creek Mill (Stouffer's) a coal-bed, 2 feet thick, nearly horizontal, under micaceous sandstone; beneath the coal there is no exposure for 6 feet; then we find yellow shale, with limestone strata—in all, 10 feet thick. Two hundred and fifty yards down the creek the same limestone layers are exposed, 12 feet thick; the upper ones pure good limestone, the lower ones yellowish and shaly. These have been opened again still farther W., and on the hill to the N.W.

As the larger bands of sandstone rise successively with an E. dip, as we approach the axis they are exposed for considerable distances along the low hills bordering the creek.

At a point half a mile above Hess and Chain's are some exposures of interest; they are descending: Blue slate and sandstone, a few feet; dark olive and bluish slate, 14 feet; in the lower part of this, a band of coarse-grained nodular carbonate of iron, 4 inches thick; slate, with many nodules of ore, 15 inches; then some impure silicious ore; and under all, dark-blue and black slate, 6 feet. For an interval of 500 yards, no rocks are exposed; then we see coarse-grained sandstone, 15 feet exposed. At the mill this is 35 feet above the creek; beneath it are blue shales, 8 feet exposed, containing small nodules of good iron-ore, lying immediately under the sandstone, but not in a regular stratum.

A fourth of a mile below this, the Upper Freeport Coal-seam again makes its appearance, rising from the water with a dip of about 10° E. 20° S. It is here very irregular, as are also the accompanying rocks above and beneath it; at one place there are but a few inches of slaty coal between roof and floor; and again there are 4 feet of good coal, with little or no slate present. Sometimes a blue slate overlies the coal, sometimes the sandstone rests in immediate contact upon the seam. This rock is a coarse-grained grey sandstone very irregularly stratified, and apparently much crushed, and full of irregular concretions. The bed has here numerous openings upon its outcrop.

For a mile below the openings in the coal-bed, exposures of sandstone underneath the coal occur along the creek. About 1¼ miles below the emergence of the 4-feet (Upper Freeport) coal, the lower smaller seam has risen from the bed of the creek, and is opened at 35 feet above the water. No measurement could be made in the deserted gangway. A coarse sandstone, full of stems and leaves of plants, here rests upon the bed. At Robinson's old saw and grist mill the creek falls over a bed of massive sandstone at one place 10 feet perpendicularly; the whole exposure is 30 feet thick.

Four hundred yards below the falls are exposed, first, micaceous sandstone, 12 feet; *coal* underneath the last, 1 foot; blue shale filled with stems and leaves, 4 feet; thinly-stratified sandstone and slate, 16 feet visible. A short distance below this point, a sandstone occurs in the bed of the stream, and soon dips gently to the W.

The valley of the creek is here, at the axis, a deep-winding chasm, with lofty precipitous bluffs, in which the successive ledges of the sandstone strata of the section appear. The land above, along the line of the axis, is barren and sandy, and is known by the name of "Brush Ridge."

4.—JACOB'S CREEK IN THE SECOND SUB-BASIN.

Descending the creek from the point where the first sub-axis crosses it towards the old furnace, marked Turnbull's on the county map, the cliffs of sandstone strata are seen sinking to the water-level, and successively disappearing under it; they form while in view the prominent feature. Upon a horizontal stratum of coarse sandstone, forming the bed of the creek, above the old forge, rest 60 feet of olive-coloured slate, changing towards its upper part to sandstone. On this rests blue shale, 12 feet, from which nodular carbonate of iron was procured to feed the furnace below, but in small quantities, and of poor quality. This furnace is deserted, and its excellent stack stands as a warning, added to the many others in our State, to manufacturers of iron to study more thoroughly their ore-deposits. An immense amount of money has in this instance been lost in buildings, scarcely a trace of which remain except the stack itself.

Upon the blue shale containing the ore lies a sandstone, 12 feet thick; upon this, blue and yellow slates, 16 feet, with a thin limestone.

Upon these slates rests a coal-bed, 2 feet thick, covered by a solid sandstone rock, 9 feet thick, and resting upon a soft blue shale.

Upon the sandstone lie slates and sandstone layers, 35 feet thick. Fragments of limestone were discovered in the surface-rubbish here; then coarse grey sandstone in thick strata, 30 feet.

To the S. of the furnace in the hill-side, 70 feet above the stack, and 1 mile from the road from Connellsville to Pittsburg, the Upper Freeport Coal has been opened, on the land of Henry Sweitzer of Brownsville, and found to yield 3 feet of good coal. The distance of this Upper Freeport Coal-bed above the lower smaller seam is 170 feet. The coal does not make its appearance on the surface where it should enter the creek. Below this point to the mouth of the creek frequent exposures of the Barren Measures occur. The distance from the furnace to the mouth of the creek is 2 miles in a straight line, but is 5 miles by the windings of the stream. Near the creek's mouth the red and variegated shales of the Barren Measures show themselves, 30 feet in thickness, of soft texture, and brightly coloured. Fragments of a calcareous stratum were picked up in connection with the shale. As the Pittsburg Coal-seam is only 25 feet above the water, on the S.W. side of the Youghiogheny River, opposite the mouth of the creek, these red shales cannot be far below that bed in stratigraphical order.

5.—LOWER COALS AND BARREN MEASURES ALONG MOUNT'S CREEK.

The hills following the base of Chestnut Ridge, S. of Lobinger's Mills, and cut by Green Lick Run, are formed of the sandstone strata among the lower coals. S. of Green Lick Run a high range of land connects the ridge with the central range of the basin, cutting off the valley of Jacob's Creek from that of Mount's Creek. The latter takes its rise in a slight gap or notch in the summit of Chestnut Ridge, and almost immediately flows into and along the Barren Measures to the Youghiogheny River. A thin coal-seam is said to have been opened above Mount Vernon Furnace; it is one of the lower coals.

From peculiarities in the topographical aspect of the country E. of Mount's Creek, rather than from any observations of exposed structural appearances, it is probable that a short axis or local flexure of the rocks exists parallel with the ridge, and extending from Mount Vernon Furnace to White's Run. The outcrop of the Pittsburg Coal-seam is here separated from the base of Chestnut Ridge by a great interval, and this intervening space is occupied by high hills, in which, at least towards the top, it ought under ordinary circumstances to appear.

Natural exposures along Mount's Creek are rare; 2½ miles above Shellenberger's mill we have this one:—Thin coal layers; blackish slate, 5 feet; coal-bed, 18 inches; grey micaceous sandstone, 8 feet; dark-blue shale, breaking up into lozenge-shaped fragments, 6 feet; light-blue and red shale, 12 feet; blue calcareous slate, full of fossils, 4 feet; blue shale, 5 feet.

The topographical sketch (Fig. 471) exhibits the remarkable retreat from and subsequent approach to the Chestnut Ridge, made by the outcrop of the Pittsburg Coal-bed *a*, under the influence of the conjectural axis. The hill *b* is capped by the *Mahoning Sandstone*. At x, at the base of the hills containing the Pittsburg Coal outcrop, are seen *the red and variegated shales* of the upper portion of the Barren Measures. At *c* and *d* are seen the outcrops of the lower coal-beds.

FIG. 471.—Map of Mount's Creek.

In the deep gap whence White Mill Creek issues, and above Breakneck Furnace at its entrance, are seen the red shales and limestone strata of the Umbral series, and not far distant an exposure of the silicious rocks of the Vespertine. At the base of the hill opposite the furnace, the fossiliferous limestone again shows itself, 4 feet thick. The Umbral ore-stratum ranges along the slope, at an elevation of 80 feet above the limestone, and over it is seen the Seral conglomerate.

Three-fourths of a mile down the Stream and 25 feet above water-level, a coal-bed, 2 feet thick, is mined: the coal is pure; the floor is white sandstone and yellow shale; roof, 2 feet of black slate and coal intermixed. Over this, 3 feet of grey slate; over this, coarse sandstone, 12 feet. The hill above, of no great height, seems formed chiefly of sandstone.

Below White's Mill, Yellow Spring Run descends from the ridge; on this run a coal-bed, 3 feet thick, is said to have been opened.

Six hundred yards above the bridge on the Connellsville Road are exposures of sandstone and a thin coal-seam 4 inches thick. Four hundred yards below this a limestone stratum, 2 feet thick, weathering yellow, occurs; upon this rest 6 feet of shale, and yellow micaceous sandstone; on this shale, 10 feet. Below the bridge, and extending to the mouth of the run, are exposures of a sandstone, 40 feet thick. All these rocks are in the upper part of the Barren Measures.

The few small runs that flow from the ridge into Mount's Creek, through gaps in the range of sandstone hills at its base between White Mill Run and the Youghiogheny, seldom expose the lower Coal-measures.

Along the Youghiogheny, where it cuts the ridge in a deep wide gap, numerous exposures occur, from which the section (Fig. 472) was compiled, some parts of it being measured, others estimated. The site of Connellsville is on the 65-feet sandstone of the section, a short distance beneath the Pittsburg Seam. The high knob opposite the town, and S. of the river, is of the same rock.

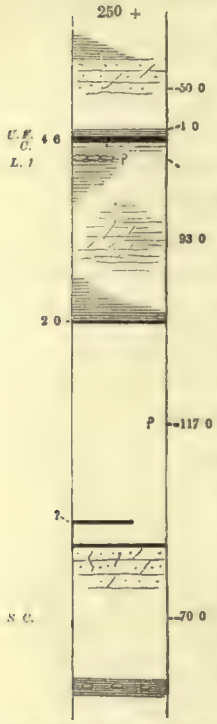


Fig. 472.—Youghiogheny Section.

Commencing our description of the section with its lowest rock, the Seral conglomerate, we find all the series up to the Pittsburg Coal dipping W., and disappearing beneath the bed of the river below Connellsville in a distance of about 2¼ miles. In the gap the rocks dip from 15° to 20°, but the dips become always gentler, until above Connellsvillle they are quite horizontal—a phenomenon repeated in every gap in Chestnut Ridge, so that, the distance of any rock from the axis being known, its inclination may be approximately calculated.

The Seral conglomerate forms the bed of the river at Rotrock's Eddy, 2¼ miles above Connellsville, and is from 60 to 70 feet in thickness. It is here a dark-grey coarse-grained massive sandstone, not a conglomerate in any part. Immediately beneath it is the Vespertine ore, hereafter to be spoken of: the sandstone ascends bold ledges nearly to the summit of the ridge.

The two coal-beds of the section are opened in the end of a high spur, the body of which is formed of the Mahoning Sandstone, and part of the shales of space 250 + of the section. The Mahoning Sandstone is probably 50 feet thick. The 2-feet coal-bed is a rich soft crumbling coal, containing very little slate, and has not been much wrought.

The larger upper (Upper Freeport Coal) bed has been opened at several points: it is at one point 3 feet thick, with a roof of yellow shale, 4 feet thick, and full of vegetable remains: on this rests a sandstone. At another place it measures over 4 feet, with roof of dark-blue slate, above which is the sandstone. The coal is good, and harder than that below, and richly bituminous.

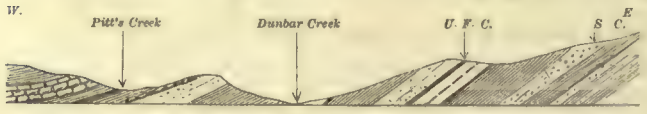


Fig. 473.

Fragments of the Freeport Limestone were found in the interval, but no rock *in situ*.

The valley of Dunbar Creek makes the middle of the section difficult to compile with accuracy. The longitudinal section will exhibit the relation of the beds to the face of the country.

The red and variegated shales are seen at the base of the hill, of which the limestone under the Pittsburg Coal forms the coping. They are about two-thirds of the way up in the series of the Barren Measures.

The third coal-seam is 1 foot thick at its exposure on the river, but to the N. of this exposure it is seen to measure 2 feet.

The Pittsburg Seam, after disappearing beneath the river a short distance below Connellsville, emerges again at a point 2 miles below the town, near the Broad ford ; and thence to the first sub-axis the river repeats the Connellsville Section in its exposures. But in the centre of the synclinal trough there is a longitudinal roll, which causes the Great Coal-seam, after having attained an elevation of 30 feet, to descend again nearly to the water, and then reascend towards the sub-axis. The presence of this roll adds probability to the suggestion that a similar one traverses the Upper Mount's Creek district, as described in page 609. For some distance the river has its course along the axis of this roll, the rocks appearing quite horizontal.

The limestone strata beneath the Pittsburg Coal are exposed at Lobinger's salt-well, 2 miles below Broadford. Here the Pittsburg Coal is 4 feet above the water-level.

One mile below the salt-well the rocks below the Pittsburg Seam are exposed ; the section is continued downwards by following the exposures of the river as it enters the arch of the sub-axis, near the town of Liberty ; and if placed in comparison with the upper portion of the Connellsville Section, exhibits the striking and endless diversity consistent with the widest and most positive general conformity. This section, expressed in words, is as follows :—

Pittsburg Coal, 9 feet ; Yellow Slate and blue shale, 16 feet. Limestone, 10 feet. Yellow Shale, 5 feet ; Interval, 20 feet ; Coarse Grey Sandstone, irregularly stratified, 25 feet ; Interval, 15 feet. Olive Shale, 20 feet ; Micaceous Sandstone, 9 feet ; Yellow Slate, 15 feet.

Three-fourths of a mile below East Liberty, and a short distance from the river, on the land of Mr Strickler, there is a coal-seam, 15 inches thick : upon this, blue shale, 4 feet ; fossiliferous limestone, 6 inches ; blue shale, 7 feet. Under the coal, blue slate, 4 feet. These rocks occur, as nearly as can be estimated, 35 or 40 feet beneath the former. The coal-seam again appears 400 yards farther down the river, 35 feet above water-level. Under it, along the river, is a continuous stratum of coarse grey sandstone, fully 70 feet in thickness : under this, yellow shale, 25 feet ; sandstone, 30 feet ; shale, 25 feet. At the old furnace, known as the Franklin Ironworks, and near the old forge and below it, a sandstone stratum, fully 40 feet thick, comes next in order : it is thinly laminated, grey, and micaceous, with dark olive shales ; it has a very gentle East dip. Here fragments of coal are found in the soil, but the seam is not visible.

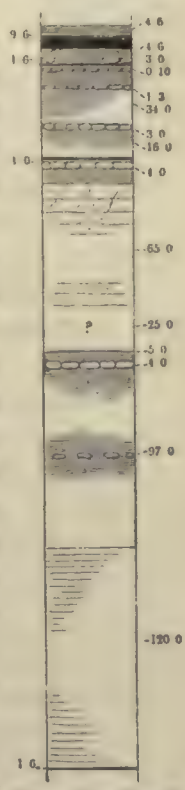


FIG. 474.—Youghiogheny Section, lower part of Connellsville.

One and a half miles below this upon the river are horizontal strata of coarse grey sandstone ; 30 feet of this are seen exposed half a mile below, and other similar exposures as far as " the rapids," where the river has a very considerable descent over the lower sandstones of the Barren series (Mahoning Sandstone, &c.)

Four hundred yards above the mouth of Washington's Run, the " 4-feet " (Upper Freeport) Saltzburg Coal-bed is opened, measuring from 4½ to 5 feet of good coal, divided as usual by a thin slate-seam near the middle. Blue slate is the roof, and over this the Mahoning Sandstone.

At the mouth of Washington Run, exposures give :—

Sandstone, coarse, massive, 80 feet ; Olive Slate, 4½ feet ; *Coal,* 15 inches ; Shale, containing calcareous and ferriferous nodules, 4½ feet ; Olive Slate, 4 feet ; Micaceous Sandstone, 4 feet ; Olive Slate, 4 feet ; Micaceous Sandstone, 5 feet ; Blank at the mouth of Washington Run, perhaps 65 feet ; Blue Shale, 4 feet ; *Coal,* 4½ to 5 feet.

If the lower bed be the Upper Freeport Coal, as we suppose, the upper one is the Elk-Lick Coal ; or the upper one may be equivalent to the third coal-bed in the Connellsville Section across the sub-basin.

All these rocks disappear beneath the bed of the stream approaching Perryopolis, a village situated on a high hill of the Barren Measures. Nearly 2 miles below the mouth of Washington Run the following section of their upper rocks is exposed :—

Yellow Shales, 15 feet ; Solid stratum of Sandstone, 16 feet ; Sandstone, 6 feet ; Yellow Slate, 10 feet ; Red Shale, 12 feet ; and Sandstone, 24 feet ; Yellow, blue, and variegated Shales, about 45 feet above the water.

Above these rocks, at a point on the river a fourth of a mile below, is a coal-seam, 18 inches thick, a short vertical distance beneath the Pittsburg Coal. This locality is three-fourths of a mile above the Shovel Factory.

Two miles below Perryopolis the river turns to the N., and its valley coincides with the strike of the rocks for about 2½ miles. At the Shovel Factory the Pittsburg Seam is 15 feet above low-water level. Up the river it rises rapidly towards the first sub-axis; down the river, it rises slowly; and one mile above the mouth of Jacob's Creek, is 70 feet above the water: thence descending, it is seen 35 feet above the water at the mouth of Jacob's Creek. A wide roll in the rocks crosses the river at this place, therefore, but we saw no evidence of its existence N. or S.

6.—LOWER ROCKS SOUTHWARD OF THE YOUGHIOGHENY.

Dunbar Creek rises in the valley E. of Chestnut Ridge, through a deep notch in which it flows, and empties into the Youghiogheny opposite Connellsville. It traverses the Barren Measures for 2 miles above its mouth, the sandstone above described often forming from the water's edge a perpendicular wall or bluff, the surface of which is rough, with rounded cavities. Higher up towards the bend of the creek, the Pittsburg Seam, which at the river outcrops at the base of the ridge next W., sweeps round and appears at the summit of the hill above the sandstone.

Here the creek issues from the ravine in the ridge, and affords exposures of the lower series of rocks. Under the 65-feet sandstone of the section (Fig. 472) occur 16 feet of dark olive and brown shale, and in the middle of these a coal-bed from 6 to 10 inches thick, with calcareous nodules below the coal.

Two hundred yards above this, along the run at Dunbar Mill, the following section is exposed:—

Coarse grey Sandstone, confusedly mixed with yellow shale, 25 feet thick; Yellow and dark olive Slate; Blackish Slate, 45 feet; Yellow Slate, 8 feet, micaceous, flaggy. Thick coarse sandstone, 50 feet; Olive-yellow dark Slates, 6 feet. *Coal opened here* 4½ to 5 feet; at another opening it is thinner; floor, blue shale. Shales (coal not discovered) 100 feet. Seral conglomerate, 100 feet. *Coal*, 6 inches; Olive and dark-blue shales with iron ore; then limestone and sandstone strata.

The Seral conglomerate rises from the creek about a mile above Dunbar Mill, at the Old Union Furnace, as a coarse-grained, contorted, and irregularly-stratified sandstone, cropping out above the furnace 80 feet high.

S. of Dunbar Creek, the 65-feet sandstone again forms a ridge separating the range of hills containing the outcrop of the Pittsburg Coal from Chestnut Ridge. Gist's Run gives but few exposures of rock in place, and flows in the Barren Measures. For the last mile and a half of its course, having cut through the separating ridge, it courses by the foot of the slope, along which ranges the outcrop of the Pittsburg Seam. The topography changes gradually S., until, at a point opposite Mr Braddock's, the outcrop of the Pittsburg Seam is on a gentle summit, from which, going E., one crosses a broad flat, and rises very gently upon Chestnut Ridge. This flat continues but a short distance S. of Mr Braddock's, and gives place to the high land at the head-waters of Cover Run, which is a branch of Redstone Creek. There, on the farm of Mr Pennick, the Pittsburg Seam is opened. High on the side of the ridge a bed of coal, 4 feet thick, is said to have been entered, and a smaller bed at a spot to the N.E.

Proceeding S. as we approach the gorge of Shute's Run, the denudation is more considerable, the valleys deeper, and the hills sharper. Shute's Run cuts down into the Vespertine sandstones. Opposite and above the furnace the silicious and calcareous layers of the Umbral series are exposed, with the red shales of that formation, and the ore hereafter to be described. The ends of two hills, cut off from the main ridge by two small runs, present the strata of the Seral conglomerate, which are here of no great thickness, and also the sandstones related to the lower coal-beds.

The upper coal-bed (Upper Freeport Coal ?) is here 3½ or 4½ feet in thickness, and of good quality. The (Mahoning ?) Sandstone is seen above it. The other bed is said to have been also opened at one time. An occasional small exposure of shale or sandstone is all that can be observed above, in the Barren Measures.

A reliable section along Redstone Creek could not be compiled from exposures upon the first sub-

axis, because of their unfrequency, the serpentine course of the stream, and the obliquity of its traverse N.W. through the sub-axis.

The length of the course of the stream from the outcrop of the Pittsburg Seam, at water-level, on the one side, to its outcrop at water-level on the other, is between 8 and 9 miles, while a line across the axis would not exceed 4 miles. The lowest rock brought up by the axis, as would appear by a section, is about 30 feet below the lower coal. This middle point of the subordinate axis is one mile and three-fourths below the place called Middletown. The lower coal-bed sinks E. below water-level a short distance above Work's mill; and W. down the creek on Mr Hill's land, where 2½ or 3 feet of rich black solid coal is mined from the bed of the stream. Its appearance is that peculiar to the class of coals called Splint Coals: it is very hard, and exhibits no tendency to columnar structure, but comes out in long flat slabs, which break with rhomboidal fracture. Slabs 7 feet long, and not more than 8 or 10 inches thick, and 18 inches wide, have been taken out of the bed of the creek. The usual character of the other thin coals (whether mined in flowing water or in a dry hill-side) is that of a soft crumbly mass, falling readily into a multitude of small prisms ranged in vertical columns across the bed.

The upper coal-bed (Upper Freeport Coal) is exposed near the sub-axis, in a hollow to the N. of Work's mill, and is there from 18 inches to 3 feet in thickness: it is covered by slates and shales, no sandstone being visible. This is the most Western exposure of this bed on the E. side of the first subordinate axis: it descends Eastwardly, and disappears beneath water-level at Bryer's mill, near the bridge, a short distance above Middletown. It is repeatedly opened opposite the village, where it is 3 feet thick.

The small seam above the last mentioned has been opened near Mr Gadden's residence, and is said to have exhibited 2½ feet of impure slaty coal, full of sulphuret of iron.

The sandstone stratum between these two coal-beds, about 40 feet in thickness, is exposed upon the creek, and extensively quarried for the grey micaceous slabs which its beautifully regular stratification affords.

The dips on both sides of the small axis are very gentle, and the lower coal group disappears W. beneath the creek near Sharpless's mill, a few hundred yards below which the Pittsburg Seam enters the water. Not even the upper members of the Barren group are again visible until we approach the mouth of the Redstone, where a few of the strata immediately below the Pittsburg Coal-bed are brought up again by the Brownsville axis.

Let us resume the tracing of the E. outcrop. S. of the flat of Shute's Run, the hills containing the Pittsburg Coal-seam become high, approach the ridge closely, and almost abut upon its base; but they recede from it again, and diminish in height as they enclose another characteristic flat, watered by the upper tributaries of the Redstone. At Munroe the Pittsburg Seam is at the water-level, and low hills rise over its outcrop; it is not seen again until it reappears in the hills to the S. of the creek. All the rocks above and below it have been so eroded that diluvium completely conceals them from view.

The lower group occupying its usual place, the large sandstones (Mahoning Sandstone, &c.) form benches upon the flank of the ridge. Where the National Road crosses it, one of the head-branches of the Redstone cuts down to the red shales and limestone of the Umbral series, and exposes them to view; but none of the numerous excavations for the road have exposed even the black soil of any of the lower coal-seams or the Umbral ore-bands, although the calcareous and silicious strata appear in them. Unsuccessful but very careful search was made for a small coal outcrop, said to have been seen at the run in the gap. Neither does the other head-stream of the Redstone (next S. of the one mentioned) give exposures of these coal-beds, nor does it penetrate the strata to as great a depth as the other. Between these two streams the lower sandstones stand out in a high knob (apparently separate from the ridge), which is quite a conspicuous object as seen from Uniontown, and from points at a great distance to the W. and N. of it. This has led to an error in the maps of the county, where this knob is represented as a distinct mountain, while it is in fact only one of a range of hills along the side of the mountain, and it is constructed like the rest, being an isolated segment of the lower sandstones in outcrop; but is somewhat superior in height, and has deeper traces of denudation around it. A similar instance occurs farther S.

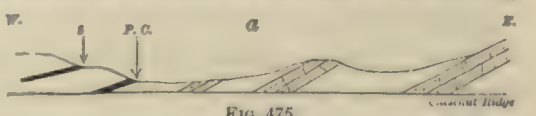


Fig. 475.

At Munroe, *a* (Fig. 476) represents a section of the ridges from the Pittsburg Coal-bed to Chestnut Ridge. One and a half miles farther S. the Pittsburg Coal-seam crosses the wide flat of Lick Run and Redstone Creek. Between the head-waters of Lick Run and George's Creek the sandstone strata of the Barren Measures are seen forming a sub-ridge, elsewhere swept away.

FIG. 476.—Section from Chestnut Ridge to the Pittsburg Coal-seam.

S. of the last locality a wide valley begins and continues to a point 2 miles beyond Oliphant's furnace, and extending from the base of the Chestnut Ridge to a range of gentle acclivities, in which the Pittsburg Coal-seam has its outcrop. The latter, however, sometimes runs its line of outcrop in the flat or terrace, but sometimes also high upon the slope. The valley widens S. towards the furnace, and when within a mile of it presents an aspect as at *b*, a knoll rising upon its surface, containing a fragment of the bed. At the furnace the outcrop is half a mile distant from the base of Chestnut Ridge, the furnace itself standing at the outcrop of the great sandstones at its base. Two miles S. of the furnace the flat terminates against a sloping spur of Chestnut Ridge, connecting it with the acclivities on the W.

George's Creek.—Outcrops of the lower coal-seams have nowhere been discovered in the transverse sections of the sandstone range of hills or terraces upon the flank of Chestnut Ridge along this valley.

Haydontown is situated at the mouth of a gorge, by which one of the forks of George's Creek issues from Chestnut Ridge. Near it one of the lower seams is opened, but which one we could not ascertain.

The S. fork of George's Creek flows through an extensive flat extending to the forks at Woodbridge, below which the valley of the creek is but a narrow pass between the hills containing the Pittsburg Coal-bed. The

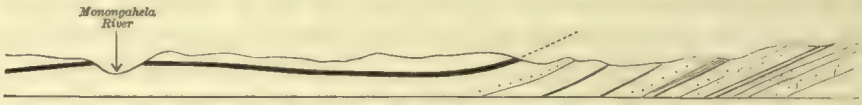


FIG. 477.

FIG. 478.

woodcuts (Figs. 477 and 478) are intended to show the shape of the basin at George's Creek and at the Virginia State line respectively. The creek exhibits numerous exposures of the Barren Measures in its course to the river.

At Long's mill, 2½ miles from the ridge, the Pittsburg Coal is 173 feet above water-level; and beneath it, 45 feet above water-level, is seen the outcrop of a small coal-seam. At the water's edge occur yellow slates, 6 feet thick, containing a 4-inch band of coarse-grained nodules of carbonate of iron; upon these rest thin layers of micaceous sandstone, 12 feet thick; yellow slate, 6 feet exposed. Coal, 2 feet, mentioned above; roof, olive slate, 12 feet; strata horizontal.

Farther down the creek, by the Morgantown Road, sandstone is seen, 30 feet of it being exposed, and underneath it a limestone stratum 5 feet thick, upon yellow slate 25 feet. These continue to exhibit cliffs down the creek, as at Crow's mill. Above Geneva, the rock begins almost imperceptibly to dip W. Half a mile above Geneva, the little coal-seam is 125 feet below the Pittsburg Seam, and disappears beneath the creek. At Geneva, the sandstone stratum beneath the Pittsburg Seam, which skirts the summits of the hills, forms high cliffs along their sides.

To the S. of the head-waters of George's Creek there runs a small valley of denudation, along the base of Chestnut Ridge; for a space of 2½ miles it is terminated at the Virginia State line by a transverse spur of the ridge. This is watered by Rubble's (McCulloch's) Run. On its W. side runs a high range of hills, still beyond which is the range in which the outcrop of the Pittsburg Coal-bed occurs, the two being separated by the valley of Grassy Run.

The accompanying sketch will explain the features of the country better than a description in the text—

a being the flat of George's Creek, *m n* the Grassy Run and McCulloch's Run, V. L. the State Line, *a a* the outcrop of the Pittsburg Seam with its openings, and *Fur.* the furnace.

At *b* a small coal-seam is opened, and the ridge above it is composed of Barren Measures. At *c* the Elk-Lick Coal-bed, 4 feet thick, is opened, and the ridge above it, composed of 40 feet sandstone, underneath the coal-bed. It is separated from Chestnut Ridge by a deep and narrow ravine; though, viewed from the W., no such separation is visible, but it appears from thence to form part of its flank. At *d*, the Upper Freeport Coals, and those below it, are opened. Here there is a deep cut in the side of the ridge, developing the Umbral red shales and rocks above.

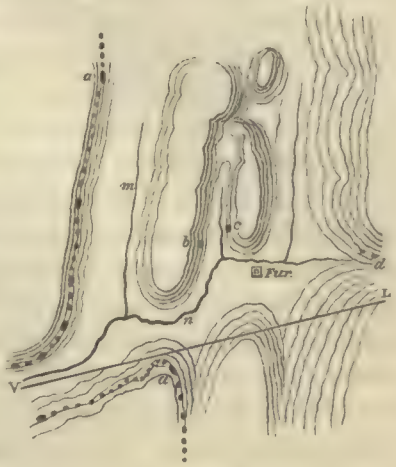


Fig. 479.

The Upper Freeport Coal (here, as elsewhere, a double bed 4 feet thick) is exposed in the ravine about 400 yards above the furnace-dam. Ore has been obtained under the coal, and a thin limestone is its associate rock.

The Elk-Lick Coal, also 4 feet thick, is opened below Mr Duncan's residence, and yields good coal. The second thin coal-seam, seen above the Elk-Lick Coal, crops out near Rubble's mill, down the run which flows from thence through the Barren Measures to its mouth, while the Pittsburg Coal everywhere occurs near the summits of the hills on either side, and in a similar position along Cheat River. Here the rocks gradually rise W., until, at the mouth of the river, the Pittsburg Coal-bed is 371 feet above water-level. The lower coal-beds are nowhere exposed along the river.

Before passing to the detailed description of the Pittsburg and upper coal-beds, a few words must be said about the general structure of the surface, from one large creek to another, along the sub-axes. The preceding description has been almost wholly confined to the sections developed in the deep thorough-cuts made by those streams. We begin with the first sub-axis at the Conemaugh.

A series of high irregular hills, composed of the Barren Measures, marks the course of the first sub-axis to the Loyalhanna. In the hollows between these hills occur frequent exposures of the upper portions of this group, but the lower coal-beds are never seen. Between the Loyalhanna and Sewickly Creek the axis is still more plainly traceable by a similar series of hills, especially if seen from Chestnut Ridge. Among the hills the red and variegated shales of the Barren Measures are commonly traceable with some of the massive sandstone strata along the runs. The thin coal-beds in that series frequently exhibit the black lines of their outcrop; but none of the ravines, except those close to the two main streams, sink to the lower coals. On some of the highest summits a sandstone is observable, which there is reason to believe is identical with the first massive stratum beneath the Pittsburg Coal-bed; also in the deepest ravines there is one, which is probably the Mahoning Sandstone, above the Upper Freeport Coal.

The hills of the axis on either side of the Sewickly (where its course is along the axis) are very high, especially those on the E. side. Near New Staunton one of the thin Barren Measure coal-beds has been opened with a thickness of 18 inches; it is full of sulphuret of iron.

From this point to Jacob's Creek the axis is not so apparent along the surface, but is still distinguishable when its hills are compared with those of the troughs on each side. Here the red shales are quite thick; they frequently occur on the hill-sides, and display here and there the unopened outcrops of the thin coal-seams.

Jacob's Creek cuts down nearly to the Seral conglomerate. S. of it the line of axis traverses very high ground, called Brush Ridge, which is sandy and barren, from the disintegration of the Mahoning Sandstone, which forms the arching rock. Here the first sub-axis seems to be at its widest.

From the Youghiogheny to the Redstone the axis is not very plainly marked on the surface. Very high knobs denote it on the Youghiogheny River. The Mahoning Sandstone appears in the deepest ravines; the Upper Barren Measures form the rest of the surface. Approaching the Redstone, the land declines in altitude as the axis is sinking and spreading out. S. of Redstone Creek the axis continues gradually to sink; the outcrops of the Pittsburg Coal-bed on each side of it approach each other, and meet at a point 2 miles S. of the National

Road, beyond which that coal-bed arches over the now almost vanished axis. At Redstone Creek there are many deep lateral depressions which cut down to the Mahoning Sandstone, but the lower coals nowhere come up much to the S. of the valley of this creek. The axis is barely determinable where it crosses the Monongahela River below the mouth of Cheat River.

The second subordinate axis causes the valleys of the Loyalhanna, Beaver Dam Run, Brush Creek, and Little Sewickly, to present exposures of the Barren Measures, but not of the lower coal-beds, except the Loyalhanna, which, as we have seen, displays them also. Here and there the smut along the crops of the thin coal-seams of the Barren Measures is seen on the sides of the hills, which, when beheld from one of the knobs along the line of the first sub-axis, mark the line of the second sub-axis. From certain points this range looks like a regular but very low ridge, broken at intervals by gentle depressions. It does not seem to have suffered so much from denuding agencies as the first sub-axis, except towards its termination, where it has been deeply trenched. A barren soil marks its whole course, the hills being composed of the sandstones and silicious shales of the Barren Measures; but along each side runs a strip of excellent land, the soil of which owes its fertility to the outcrop of the upper shales and limestone strata under the Pittsburg Coal-bed. These alternating belts are strikingly contrasted. The Greensburg and Pittsburg Turnpike crosses the second sub-axis near Grapeville.

CHAPTER XXV.

1.—PITTSBURG COAL-BED, AND THE ROCKS ABOVE IT, IN THE THIRD BASIN S. OF THE CONEMAUGH.

THE upper group of Coal-measures, with the Pittsburg Coal-bed for its base, occupies the central region of the first subdivision of the Third Basin, between Chestnut Ridge and the first anticlinal sub-axis to the W. of it, from the Conemaugh River to the Virginia line, sometimes occupying a very narrow strip of surface, of small thickness, and again, where it is of greater thickness, spreading over a wider belt. In describing it, the Eastern and Western outcrops will be traced from stream to stream.

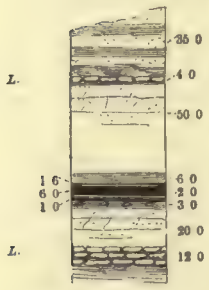


FIG. 480.

Upon the Conemaugh (as will be seen by a reference to Fig. 480), at and opposite to Blairsville, there are very few rocks above the Pittsburg Coal-bed preserved in this basin. A Section here includes the following strata:—

Yellow and olive Slates, with sandstone, 35 feet; Limestone, 4 feet; Coarse Sandstone, irregularly stratified, 50 feet; Black Shale, 6 feet, with *Coal*, 1 foot; *Coal*, 6½ feet; Black Slate, 2 feet; *Coal*, 1 foot; Dark-blue Shale, with iron nodules, 3 feet; Micaceous Sandstone, grey thin strata, 20 feet; Limestone, with shaly layers, 12 feet, &c.

The Pittsburg Coal is finely exposed with its superposed sandstone at the mouth of McGee's Run, 6 feet in thickness: beneath it yellow slate and sandstone, 10 feet; then limestone with interposed layers of blue slate, 8 feet; then yellow and blue slate, 15 feet.—(See Fig. 481).

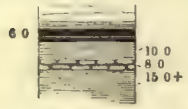


FIG. 481.

At one exposure the coal is divided (as in Fig. 482) thus:—

Coal; black Slate, 1 foot; *Coal*, 18 inches; Shale, containing nodules of carbonate of iron and carbonate of lime, 18 inches; Yellow Slate.

The scattered nodules have become a solid bed of limestone 2 feet in thickness, and separated from the floor of the coal-bed by a few feet of slate. Beneath the coal are—

Black Slate, 1 foot; Nodules of iron and limestone, 18 inches; Blue Shale, 6 inches; Nodules of Limestone, 1 foot; Blue Shale, 18 inches; Blue Slate, 3 feet.

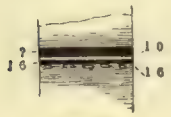


FIG. 482.

At Wallace's Mill, a short distance S.W. of the mouth of the Run, the coal is 6 feet thick, but over it rest shale and sandstone, 20 feet; then limestone in two beds 5 feet thick.

The sandstone at the river has here been subjected to one of its local changes (Fig. 483). At the mill, 1 mile S. of Wallace's mill, the coal, 6 feet thick, rests upon sandstone, while the rough brownish-grey Pittsburg Sandstone is seen in the hill above. The dip is here to the N.W., at a sensible angle.

Fig. 484.—Pittsburg Coal-Seam.

From this point to Derry there are few exposures of the coal-bed. Half a mile to the E. of Derry, it is opened, and is 7 feet thick; it is also frequently opened between this point and the Loyalhanna. At Mr Shall's bank it is 8 feet thick, having much shale and slate-rock, containing a few silicious layers over it. It dips under water-level on the Loyalhanna Creek above Baldridge's mill.

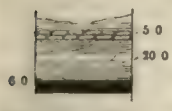


Fig. 483.—Pittsburg Coal-Seam.

Upon its Western outcrop, between the Conemaugh and Loyalhanna, the Pittsburg Coal has numerous openings. They follow its gradual rise along the river Westward. Opposite Blairsville it is 115 feet above the water-line. Above the coal are yellow and bluish shale 12 feet, coarse grey massive sandstone, irregularly stratified, and weathering with roundish holes, 30 feet; limestone, yellowish, impure, 4 feet; and yellow and olive shales, 35 feet. The hill rises to a considerable height above, but presents no farther exposures.—(See Fig. 486.)

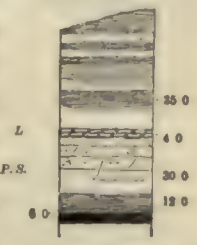


Fig. 486.—Conemaugh.

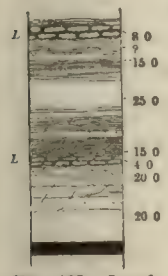


Fig. 485.—Loyalhanna River.

The distance between its Eastern and Western outcrops increases Southward, the basin deepening, and permitting a second superior limestone to come in, as seen in Fig. 485.

At New Derry, 6 miles S. of Loyalhanna and Blairsville, the distance across the area of the bed is $1\frac{1}{2}$ miles.

There are a number of openings 4 miles W. of New Derry, under an elevation, called the Barrens, formed of the Pittsburg Sandstone above the coal. The bed is $7\frac{1}{2}$ feet thick, a thin seam of slate separating the lower 2 feet of coal as an under bench (Fig. 487); the roof is of black slate containing thin layers of coal. The dip is gently Eastward, but the bed, as exposed along the Little Run, exhibits several wrinkles or gentle undulations.

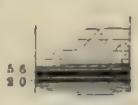


Fig. 487.

South-westward to the Loyalhanna, openings are numerous; the bed, after reaching the Creek, descends slowly in an Eastwardly course to the water, under which it dips at Chambers's mill, about 300 yards W. of the centre line of the trough. Here is seen, beneath the coal, slate 8 feet thick; resting upon limestone, 6 feet (see Fig. 488). The Pittsburg Coal itself is about $8\frac{1}{2}$ feet thick, the Pittsburg Sandstone above it forms the banks of the creek, back of which, to the N. and S., along the centre of the trough, there stretches a beautifully level country, presenting no rock-exposures higher in the series. About a fourth of a mile below Baldridge's mill, however, we have exposures (Fig. 486) as follows:—

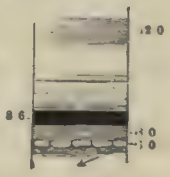


Fig. 488.

Limestone, in thick layers, 8 feet, exposed at the summit of the hill, about 100 feet above the Pittsburg Coal; Interval; Olive and yellow Slate, with sandstone strata, 15 feet; Yellow silicious Slates, 25 feet; Dark-blue Slate, upper part silicious, 15 feet; Yellow Slate, with limestone in alternating layers, 4 feet; Coarse-grey Sandstone, with occasional layers of slate between it and the coal, 20 feet out of 40 exposed. *Pittsburg Coal*, 8 feet. Beneath it, 80 feet, with no exposures.

Along the middle of the trough the hills are generally composed of the sandstones and shales above the first limestone-band, and in these are occasionally seen the smuts of one or two small coal-beds, nowhere opened. These coal-beds are doubtless the equivalents of the first two thin coal-beds of this upper group, viz. the Redstone and Sewickly seams.

2.—PITTSBURG COAL S. OF THE LOYALHANNA—FIRST SUB-BASIN.

This bed appears at Baldridge, in the bank, 500 yards above the mill, upon a stream which flows into the Loyalhanna. The coal, as opened, is between 7 and 8 feet in thickness; sandstone in some places rests immediately upon the coal, at others it is parted from it by 5 or 6 feet of slate. The coal-bed ranges through the adjoining hill, and issues upon its Eastern face on the Greensburg Turnpike, where it is 8 feet thick. There are many openings upon the Eastern outcrop besides this one.

Half a mile from Youngstown, 20 feet of blue and blackish slate rest upon the coal, while but a short distance off, at the creek, coarse sandstone occupies the same interval.—(See Fig. 491.)

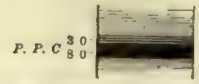


FIG. 489.—Pittsburg Coal, Nichol's Bank.

Two and a half miles S.W. of Youngstown, a range of hills, too low to receive the Pittsburg Coal at their summits, lie between the Chestnut Ridge and the high lands in the centre of the trough, at the very base of which the Pittsburg Coal shows its outcrop. This is the case at Mr Nichol's bank, where the seam measures 8 feet, with a stratum of alternating coal and slate 3 feet more above it, as in Fig. 489. This is perhaps a mile Eastward of Pleasant Unity. Openings are numerous from thence to the Big Sewickly Creek, along both sides of the valley of which the seam is frequently exposed and mined. At Fisher's mill, upon the Sewickly Creek, the second limestone above the Pittsburg Coal, at water-level, and nearly horizontal, is composed of four strata; the uppermost is 3 feet thick, the next 16 inches, next 12 inches, lowest 2 feet. Eighteen inches of slate separate these from two more, each 6 inches thick. Some of these layers are of a bright ochre yellow, others a pure blue.

FIG. 490.

A mile below the mill, a coal-bed 5 feet thick appears (Fig. 491), which is doubtless the Sewickly Bed, covered by dark-blue and brownish slates, 20 feet; below it are hard bluish-grey slates. The coal is solid and pure, richly bituminous, and free from slate. The height at which it stands above the Pittsburg Coal is rather doubtful. At first it was estimated at 45 or 50 feet, but, allowance being made for dip, it may be nearer 80 feet. In this interval we find micaceous sandstone 12 feet exposed; the latter resting upon the Pittsburg Coal, here 9 feet thick, and occupying, where first seen, the bottom of the creek.

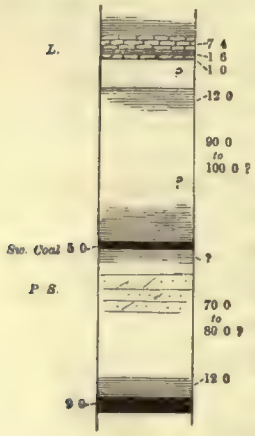


FIG. 491.—Sewickly Creek.

Upon the Western outcrop, the Pittsburg Coal rises along the Southern side of the Loyalhanna Valley, from Chambers's mill, with a dip of 10° to 13°. It is cut at Beatty's Station of the Pennsylvania Railroad, and is frequently drifted in upon at points between the creek and the Greensburg Turnpike. It always yields about 8 feet of coal, and has usually, as its roof, a stratum half slate, half coal, and from 2 to 3 feet in thickness. It crosses the turnpike near the sixth milestone. Over it here is a mass of brownish shale in place of the coarse-grained Pittsburg Sandstone.

At the coal-banks S. of the Turnpike it is 8 feet thick, and bears its upper slaty member, but dips more steeply than usual. Southward it is opened at several banks, and at last in a deep ravine, cutting down to the Sewickly. It passes this ravine, however, Westward, and is mined on the hill overlooking the first sub-axis.

The two ranges of outcrop are, in this section of the trough, distant from each other from $1\frac{3}{4}$ miles in the deepest ravines to $2\frac{1}{4}$ in the highest land.

Upon the Loyalhanna we have 107 feet of rocks above the Pittsburg Coal. The highest rock in this district is a limestone, capping a hill about one-fourth of a mile below Baldridge's mill. Higher rocks lie unexposed in the more central summits of the trough; these are principally olive and yellow slates and sandstones. The side-hills N. of the turnpike do not rise to any great height, being usually capped by the limestone when the Pittsburg Coal is mined in the bottom of the ravines. The hills more in the centre exhibit the limestone in their ravines, and are themselves built up of superior rocks.

These central hills Southward of the turnpike become very lofty, and near their summits is seen the outcrop of another coal-bed, which may be the Uniontown Coal. The hills decline again as we approach the valley of the Sewickly Creek, and contain two outcrops of apparently thin seams above the first limestone-bed, and one between it and the Pittsburg Seam. The limestone descends both ways to the level of the water of the Sewickly Creek, and is estimated to be 170 feet above the Pittsburg Coal.—(See Fig. 491).

3.—THE PITTSBURG COAL-BED SOUTHWARD OF THE SEWICKLY.

The E. outcrop of the Pittsburg Coal, after passing the Sewickly, approaches closely to Chestnut Ridge,

and ranges along the first line of hills facing the ridge. Openings upon it are numerous. At Lemon's bank the bed measures 8½ feet, upon which is 1 foot of black slate, and upon this again coal, with thin layers of slate, 3 feet thick; this is covered by 1 foot of slate, and then the Pittsburg Sandstone (see Fig. 492). At Mr Moyer's bank, 1 mile S.W. of the last, 8 feet of coal are covered by coal and slate interlayers 4 feet in thickness.

Fig. 492.—Lemon's Coal.

Towards Jacob's Creek it is frequently mined, as at Hooker's and Lobinger's banks (the latter on the turnpike), where the coal and slate top-bench are also 4 feet thick. This general feature varies in different localities only in the proportions maintained to each other by the coal and slate. At Jacob's Creek the Pittsburg Coal descends along the stream with a dip of 8° or 10°, and is opened on Mr Sharp's farm (where 5 feet of slate and coal form the upper member), and at Moyer's bank, 300 yards below Meshoyer's mill, 20 feet above water-level. Here it is 10 feet thick, with 4 feet of coal and slate above it (see Fig. 493). At Terisman's it is but 8 feet above the water, and of the usual size, and dips beneath the water below the mouth of Green Lick Run. It is opened also half a mile N. of "the Chain Bridge."

Fig. 493.—Moyer's Coal.

There are other openings upon a stream that enters Jacob's Creek at the bend below the bridge. The bed passes through the hill to the W., and is opened at Overholt's mill in the next parallel ravine, and almost upon a horizontal plane, and might be opened at the end of the hill near Jacob's Creek. It rises rapidly through the next hills W., and soon caps the hills, and outcrops towards the next sub-axis.

Upon its W. outcrop the Pittsburg Coal-bed was opened one-fourth of a mile below its first reappearance upon Sewickly Creek, with a dip of 2°—it was 8½ feet thick; roof bluish slate, with thin coal-layers, 2½ feet; on this, coal with thin slate-layers, 2½ feet; yellow slate, 8 feet exposed (see Fig. 494). Twenty feet beneath it there is a small exposure of limestone.

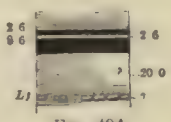


Fig. 494.

Half a mile S. of the creek, at Mr Byer's bank, it measures 9 feet in its lower member, and 5½ in its upper one, somewhat subdivided, and containing very little slate (see Fig. 495). At the next bank the upper member is 4 feet thick; and still farther S., and at a number of the openings between this place and the turnpike, it exhibits the same features.

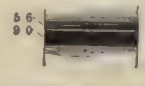


Fig. 495.—Byer's Coal.

At the turnpike, 1½ miles W. of Mount Pleasant, it yields 9 feet of coal as before; but over this are 18 inches of bluish slate, and over this again 4 feet of coal and slate, the dip being 8° or 10° E., 25° S. From hence to Jacob's Creek are numerous banks, the last being at the steam sawmill, 2¼ miles S.W. from Mount Pleasant, and not far above water-level. W. of this, it is opened high up upon the hills, as at Funk's. Stouffin's opening is in a small valley, which cuts deep into the rocks of the synclinal trough. When within 2 miles of Jacob's Creek, it is opened in the summit of a high hill belonging to Mr Mangmaugh. Hence it descends to Overholt's mill (before noticed) with a dip of six degrees.

4.—ROCKS ABOVE THE PITTSBURG COAL, SOUTH OF THE SEWICKLY CREEK, IN THE FIRST SUBDIVISION OF THE THIRD BASIN.

The limestone of the middle of the section upon the Sewickly, as was before said, descends to water-level. Above it, in the middle of the basin, the hills rise to a great height, containing another limestone stratum, and another coal-bed large enough to be worked in a number of places. Fig. 496 is designed to show these in their order; the intervals are not measured, but estimated, the lower two with a levelling instrument to assist the eye. The whole group occurs in but few hills between Jacob's Creek and the Sewickly. The section reads as follows:—

Sandstone and Slate, at the top of the highest hills, 70 feet. *Coal*, 5½ to 6 feet; Sandstone and Shale, 50 (?) feet. *Limestone C.*, 8 feet; Yellow olive Slates and Sandstones 60 (?) feet. *Limestone B.*, 8 feet; Slates, Sandstones, and Shales, exposed along the creek, 100 (?) feet. *Coal*, Sewickly, 4½ feet; Slates and Sandstones, 80 (?) feet. *Pittsburg Coal*, two members, lower one, 9 feet. Total, 387 feet.

The Sewickly Coal is opened on the N. side (see Fig. 491), and once again S. of the Sewickly at Mr Hurst's, and its outcrop repeatedly appears elsewhere.

FIG. 496.—Between Sewickly and Jacob's creeks.

The limestone above it is frequently exposed along its E. outcrop, in the hills that succeed the range containing the Pittsburg Coal. Eight or nine feet of it are seen on the Clay Turnpike and near Mount Pleasant; but its outcrop does not approach Jacob's Creek very closely, owing to the denudation in that part of the basin of these upper measures. It is also frequently quarried along its W. outcrop.

The upper limestone is seldom conspicuous, and crops out only in the highest hills of the centre of the trough. It is quite a pure limestone, but its thickness is doubtful. It is exposed a short distance N. of Mount Pleasant, and near the Presbyterian Church 3 miles N., as well as in a few spots S. of the town.

The Uniontown Coal-bed (as we shall call it, though its identity is not certain) is 5½ feet in thickness; is the highest observable coal in the district: it is worked on Mr Reynolds' land, at about a mile and a half S. of the Sewickly Creek, near the summit of the highest hills along the central line of the basin.

Here it yields a somewhat soft coal, for want of a good roofing, to prevent the small quantity of pyrites which it contains from decomposing and breaking up the coal. It was also opened on the summit of the first hill S. of the Sewickly. The high hills to the W. of Mr Reynolds' bank doubtless contain the same bed, and would afford a better covering, and therefore better coal. Two miles S.W. from Mr Reynolds' it was also opened, and measured, on examination, 6 feet of coal, with much interlaminated slate. It is opened again at the high hills 2 miles N. of Mount Pleasant, and roofed by a thin brown shale; it yields 5 feet of soft coal. An exposure of limestone may be seen 400 yards N. of the bank. Near Mount Pleasant there appears to be an old opening upon the coal-bed.

The high hills S. of Mount Pleasant do not take in the coal-bed, though they frequently exhibit the outcrop of the limestone below it.

The rocks above the Uniontown Coal-bed are chiefly yellow and olive slates and shales, in some bands almost black.

5.—PITTSBURG COAL, SOUTH OF JACOB'S CREEK.

From the land on the E. side of Jacob's Creek, for half a mile below the "Chain Bridge," the Pittsburg Coal-bed has been swept away, with the exception of a small round hill, a short distance above the bridge, which is capped by it. From thence the E. outcrop of the coal-bed crosses Jacob's Creek, upon the central line of the trough, 60 feet above the water, and rises gently S. It is wrought three-fourths of a mile S.W. of the bridge, and where it crosses the road from Mount Pleasant to Connellsville, 1½ miles from the bridge. It might be worked in the hill between this place and the spot where it recrosses the same road farther on. Beyond this latter point it bears away S.W., receding constantly from Chestnut Ridge. Along this line it has been opened by Mr J. Shark and Mr G. Kelly; the coal is 9 feet thick, and the coal and slate above, 3 feet (see Fig. 497); also by several persons 4 miles N. of Connellsville, where the coal measures 9 feet, capped by coal and slate above 4 feet high on the hill at the base of which appear the variegated red-shale bands of the Barren Measures, and where Mount's Creek cuts into the trough, 2 miles from Connellsville; then leaping across the valley of Mount's Creek and White's Run, it appears on the N. side of the hills S. of the former. It crosses the Connellsville Road a short distance S. of White's Run, and is opened at the road, and again near the summit of the hill. It again crosses to the W. side of Mount's Creek, which for a mile and a quarter has scooped its valley out of rocks lying above the Pittsburg Coal-bed, the limestone far above it forming the summit-rocks of its side-hills. Where the Pittsburg Coal recrosses the creek, it forms the bed of the stream for a considerable distance. After rising to the hill-side, to

FIG. 497.—Mount's Creek.

pursue its S.W. course, it is frequently opened by citizens of Connellsville owning lands along its outcrop. It yields 9 feet of solid coal in its lower member; and the openings are so constructed that large waggons are driven into them. At one point a slide exhibits the rocks above, as expressed by Fig. 498, namely:—

Coal, 9 feet; above it blue Shale, 6 inches. *Coal*, 15 inches; Blue Shale, 7 inches; *Coal*, 1 foot; Blue Slate, 14 feet. *Coal*, 12 to 15 inches; and upon this blue Slate, 12 feet.

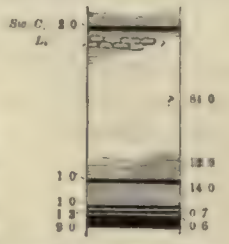


FIG. 498.—Connellsville.

The one-foot coal-bed may be considered as the Redstone Coal, but neither the Great Limestone nor the Pittsburg Limestone manifest their presence at all. In Fig. 499 thin bands of sandstone are shown above the coal.

The outcrop of the Pittsburg Coal again crosses Mount's Creek, at above one-fourth of a mile from its mouth, and then the river a few hundred yards above the point of junction of the two streams. The triangle thus cut off contains a round hill, through which the plane of the Pittsburg Coal-bed passes: this has been nearly exhausted of its coal by the Gibson Bank gangway, about 350 yards below the bridge at Connellsville. Fig. 499 gives its thickness and character, the lower bench being 9½ feet of solid coal; the upper member 4½ feet of coal and slate, with 12 inches of slate between the two.

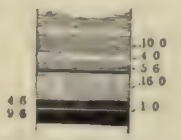


FIG. 499.—Youghiogheny River.

Upon its W. outcrop, the Pittsburg Coal-bed has been opened in numerous places S. of Jacob's Creek, at Wade and Fullerton's mill, 80 feet above the creek-level—coal usual size; and near Jacob's Creek Mill, where the creek flows directly towards the first sub-axis.

After leaving Jacob's Creek, it was opened by Mr Hurst and others along a draught coming down from the W. There is near Mr Hurst's house a single hill composed of rocks above the Pittsburg Coal, standing at the head of a valley which extends S. into the Youghiogheny at Lobinger's salt-well, 3½ miles below Connellsville. The seam is opened on both sides of this little valley. It caps a hill half a mile to the W. of Mr Hurst's, and leads its W. outcrop S. upon the Youghiogheny, 500 yards below Lobinger's salt-well. Mr Taylor opened it at 40 feet above the water-level; and other openings are made into it at different levels as it declines gently E. up the river-bank. At the salt-well it stands 4 feet above the water. The roll, once before described, lifts it again about 30 feet, and allows it once more to descend and disappear at the Broad Fording, to emerge at Connellsville.

From its disappearance at the Broad Ford, to its reappearance below Connellsville, the distance is about one mile and a fourth; but across, in a straight line from one outcrop to the other, is not more than three-fourths of a mile. It everywhere retains one uniform aspect.

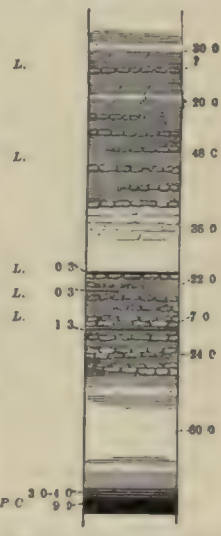


FIG. 500.—Youghiogheny River, 1 Sub., 3 Basin.

North of the Broad Fording, a ravine comes down into the valley of the river, and along its sides the Pittsburg Coal-bed has been repeatedly wrought.

The mass of rocks above the Pittsburg Coal, between Jacob's Creek and the Youghiogheny River, is not of considerable thickness, particularly on approaching Jacob's Creek. The strata immediately superposed are for the most part slates and shales, the Pittsburg Sandstone nowhere making its appearance.

The Sewickly Coal-bed shows its outcrop in a few places, as at Shoemaker's Bank upon the E. line of outcrop of the Pittsburg Coal, and above it. It is opened a little below the mouth of Mount's Creek, and is 2 feet thick, with a thin floor of slate, and beneath that a thick stratum of limestone; and its outcrop continues to be seen along the S. side of the river for some distance below Davidson's mill. Above it are slates and sandstones (Fig. 498). Below the Broad Ford it is exposed 84 feet above the Pittsburg Coal, and is 15 inches thick. It is not traceable along the W. side of the sub-basin.

The Great Limestone makes its appearance in the first hills S. of Jacob's Creek, and continues more or less exposed at intervals upon the highest middle hills to the river; but where the Pittsburg Coal outcrops at their feet, the beds of the Great Limestone cap the summits of the hills along each side of the basin. At the Youghiogheny River, interstratified, argillaceous, and calcareous layers are of great thickness (as represented in Fig. 500), and are divisible into two groups.

At the steep ledge of rocks above the Broad Ford, 35 feet of limestone alternating with slates rise above the road (itself 15 feet above the water); and upon this, sandstone and slate, coarse and fine strata, 50 feet; above this again, 40 feet of limestone; then sandstone and slate. These rocks form the cliffs of the locality.

Below the Broad Ford a section (represented in Fig. 500) was made upon a continuation of the same escarpment which overhangs the river; it is as follows:—

Slate and Sandstone 30 (?) feet. *Limestone*, unknown thickness; Sand and Slate, 20 feet. *Limestone* and *Slate* in alternate strata, 48 feet; Micaceous Sandstone, in thick and thin strata, upper part flaggy, 36 feet. *Coal*, 3 inches; *Limestone* and *Slate*, upper part black limestone with black slate, and 3 inches of coal and 5 inches of black slate, 22 feet; *Limestone*, yellow, nearly solid stratum, 7 feet; *Coal*, 15 inches. *Limestone* with *Slate*, 24 feet; Slate and micaceous Sandstone, with some black shale, 60 feet. *Pittsburg Coal*, upper and lower members, 24 feet above the river.

It is very obvious that the vast increase of calcareous matter has some close connection with the partial disappearance to the N. of the prominent Sewickly Coal-bed, and probably also with the absence of the Redstone Coal-bed beneath it. In some of the preceding sections the imperfection of the series of exposures may veil the presence of even large beds, but here the beds are evidently represented. It may be hereafter discovered that the 3-inch coal is the Sewickly Coal, and the 15-inch bed the Redstone. Upon the Sewickly Creek no limestone seems to be in connection with the Sewickly Coal. Here it lies in the midst of 50 feet of limestone and shale. At Pittsburg, Wheeling, and Morgantown, we have a recurrence of this phenomenon.

This rate of increase in the amount of calcareous matter, in the short distance from Jacob's Creek S. to the Youghiogheny River, suggests conjectures respecting the line of ancient margin of the deep water, implying that it stretched across the basin between the present lines of these two streams.

The rocks just described form the remarkable mural ridge between Mount's Creek and the Youghiogheny.

6.—PITTSBURG COAL, SOUTH OF YOUGHIOGHENY RIVER.

After leaving the flat which borders the river on its S. side, the Pittsburg Coal rises along its E. outcrop, —described when discussing the lower rocks in that section of the basin—and is opened at numerous banks belonging to various persons, and upon the Mount Braddock lands.

East of the Mount Braddock House, in the little valley at the base of Chestnut Ridge, we have the section exhibited in Fig. 501.

The strata are Limestone and yellow Slate, 5 feet; Black Slate passing into coal, 5 feet; Coal, with intervening layers of slate, 3½ feet; (Red-stone Coal?) Blue Slate, 1 foot; Yellow Slate, with limestone, and iron ore in nodules, 11 feet; Limestone, 12 feet; Blue and yellow Slate, thin coal and limestone, 4 feet; Yellow Sandstone, with thin layers of black slate, 15 feet. Pittsburg Coal, upper bench 3 feet, and lower bench 9 feet. The exposure is at the base of the hill facing Chestnut Ridge.

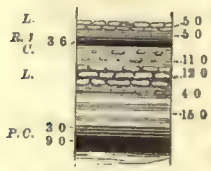


FIG. 501.—Mount Braddock.

The Pittsburg Coal is opened S. of this in four or five localities, and in the flat of Shute's Run it is opened for 1½ miles, as far as Brown's bank, at Munroe near the National Turnpike, and at water-level, on the E. side of the hill which rises from the base of Chestnut Ridge. From this point S. its outcrop is below water-level, and it is not exposed again until it crosses the wide flat of Redstone Creek, at the base of the ridge.

In its W. outcrop, S. from the Youghiogheny River, the Pittsburg Coal-bed is opened below Lobinger's salt-well, 35 feet above the water. The coal is 9 feet thick; roof, black slate, 1 foot; upper member, coal and slate in thin layers, 3 feet; olive slate, 12 feet.

From East Liberty there is a range of openings S. to the Redstone. At Oldham's the coal is 9 feet 4 inches thick. The coal exhibits a similar character at all the openings, which are numerous, and it lies with its plane so little inclined to the horizon that the openings are frequently half a mile to the E. or W. of each other, the hills being very high, and frequently cut by sharp and deep ravines, which afford abundant opportunities for drifting in upon the bed.

South of the Clay Turnpike the coal-bed is opened on both sides of Bates' or Craig's Run. At Redstone Creek it is wrought by Messrs Luckley and Carter, dipping under the creek at the opening belonging to the latter gentleman.

7.—ROCKS ABOVE THE PITTSBURG COAL, S. OF THE YOUGHIOGHENY RIVER.

The rocks which crop out above the Pittsburg Coal-bed towards the E., at Mount Braddock, are given in Fig. 501. We there see no trace of the Pittsburg Sandstone, so finely developed upon the streams farther N.

The *Sewickly Coal* is opened, as was said, on the N. side of the Youghiogheny River: it is also opened a short distance S. of the river, yielding from 2½ to 3 feet of coal; but it is not again seen until we arrive at a point 1½ miles to the S. of Mount Braddock, where it is 4 feet thick, with thin laminæ of black slate running through it, and an undermining of 1 foot of the same; the roof is soft black shale, 4 feet thick. Its outcrop is seen on the hill-side, above Mount Morey's drift, in the Pittsburg Coal, and at an elevation of about 70 feet. The presence of this bed at such an elevation justifies the assumption that the small bed at Mount Braddock (see Fig. 502) is the Redstone Coal, although its outcrop was not seen at this locality (see Fig. 503.)

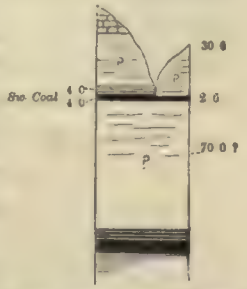


FIG. 502.—South of Mount Braddock.

This (Sewickly) Coal-bed, from 4½ to 5 feet in thickness, is opened again on the outcrop of the Pittsburg Coal-bed, at McEwan's mill. It is here a good coal, with little slate; floor, blue slate; roof, black slate 3 feet, and upon this, limestone in thick strata. This is near Shute's Run, along the hill-side of which are seen a number of old openings upon the bed. It dips beneath the water of Sharpe's Run 250 yards to the E. of the road from Uniontown to Connellsville. Above it, at this locality, lies a stratum of yellow and grey limestone, 14 feet thick.

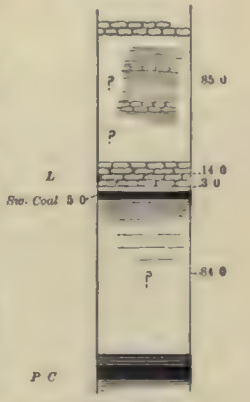


FIG. 503.—National Turnpike.

At the National Turnpike it is opened with 5 feet thickness of good coal, and at an elevation of 84 feet above the Pittsburg Coal by measurement. It is not again opened N. of the Redstone. On the W. side of the basin are no openings upon this seam; but its outcrop, apparently of considerable thickness, occurs at the proper height above that of the Pittsburg Coal, as on the road from Liberty to Connellsville, 300 yards up the hill from Mr Dickenson's bank.

The Great Limestone, represented in two vast bands in the Youghiogheny section, continues, in the country S. of that stream, to characterise the rocks above the Pittsburg Coal. Its numerous strata are of every variety of hue and structure, and are separated from each other by yellow and bluish shales, which often enclose nodules of limestone, some of the layers of which are fossiliferous.

Fine exposures of this calcareous formation are furnished on the two sides of the trough, S. of the Youghiogheny River, as upon Mill Run, over several coal-banks at the Mount Braddock openings, Mason's bank, and elsewhere. At the latter place the limestone makes its appearance 30 feet above the Sewickly Coal-bed. At Evans's mill it rests within a few feet of the coal, and 14 feet of it are exposed; how much of the interval between it and the next exposure is made up of limestone strata, is not known. At no one point between the Youghiogheny and Redstone Creek is there an exposure from which a complete section of the whole of this calcareous deposit may be easily compiled.

Along the central line of this first subdivision of the Third Basin stand isolated knobs, of such a height as to be seen from great distances, even seducing the eye into a belief that they are but a little lower than Chestnut Ridge. Moreland's Hill is one of these. Others have also received particular names. They afford few exposures, but evidently consist of shales and sandstones high in the upper series. A few limestone strata of considerable thickness, and several unopened coal-beds, exhibit their outcrops among these strata. The summit-rocks may be considered as at an elevation of 450 or 500 feet above the plane of the Pittsburg Coal-bed. That portion of them which is above the upper division of the Great Limestone is composed of yellow and olive shales, brownish

slates, a few thin layers of limestone, and a thin smut or two of coal. They generally occupy a separate range of hills, but sometimes outcrop along a continuous ascent, at the foot of which are the openings upon the Pittsburg Seam. The tops of these hills are in the central line of the basin.

The outcrop of the highest coal-bed is seen along the Youghiogheny River, but is not opened for 4 miles to the S. Here, within three-fourths of a mile of the Clay Turnpike, and 5½ miles S.W. of Connellsville, it is mined by Mr Gilcrease, and is 4 feet thick; the roof, brown slate and sand. A short distance to the E. of this place, Mr Cox opened a bed of alternating coal and slate 5 feet in thickness, resembling one opened at Mr Markley's paper-mill, upon Sewickly Creek (hereafter to be described); but the apparent height of this bed above the bed on Mr Gilcrease's land forbids their identification. The latter bed also displays a wholly different character, yielding 4 feet of solid coal, containing very little slate.

Approaching the Redstone Creek, the hills become less elevated, are separated by wider valleys of denudation, and present gentler declivities.

8.—PITTSBURG COAL, AND STRATA OVERLYING IT, ALONG THE REDSTONE CREEK, AND SOUTHWARD.

The sections exhibited in Figs. 504 and 505 were obtained from numerous exposures at and above Uniontown, upon the Redstone Creek, both by measuring and estimating the intervals; they are as follows—(see Fig. 504):—

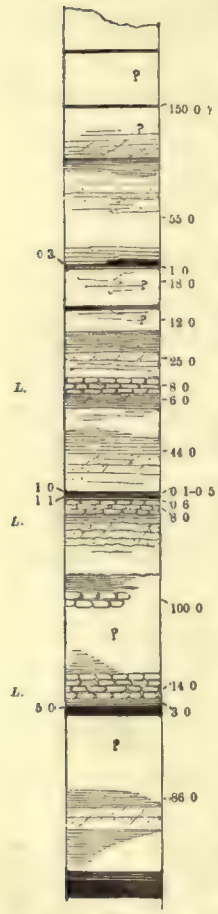


FIG. 504.—Uniontown, Redstone Creek.

From the tops of the highest hills downwards, yellow and olive shales and micaceous sandstones, with as many as three included coal-seams of unknown thickness, 35 feet apart, perhaps 150 feet. Olive Slate, and thin olive sandstone layers, soft greenish and dark-brown shale, 55 feet; *Coal*, impure, slaty, 15 inches; Blue Shale, 12 inches; Sandstone and olive Slate alternating, 18 feet; Appearance of coal, interval unknown, 12 feet; Olive Slate and grey sandstone, with black layers like coal-smut, 25 feet. *Limestone* and slate, 8 feet. Shale, yellow and bluish, 6 feet; Yellow Slate containing nodules of carbonate of iron, changing shortly into sandstone, finely flagged, and micaceous, 44 feet. *Coal*, 1 foot; Black Slate, from 1 to 5 inches; *Coal*, 13 inches; Black Slate, 6 inches. Limestone, 8 feet; Micaceous Sandstone, contorted strata; Interval, with limestone of unknown thickness; Limestone massively stratified, rough, yellow, and grey, 14 feet; Black Slate, 3 feet; Whole interval between coals measured, 100 feet. *Sewickly Coal*, 5 feet; Blue Shale floor; Interval, containing some layers of brownish slate and micaceous sandstone, 86 feet, to the *Pittsburg Coal-bed*.

The following is the succession displayed above Uniontown:—

Thick Limestone strata, 12 feet; Alternations of limestone, sandstone, and shale, thickness unknown; Limestone in thick strata. Dark-blue Slate, 15 feet; Soft-blue argillaceous Sandstone, with included layers of limestone, supposed thickness, 110 feet; Coarse grey Sandstone irregularly stratified, curled, and full of black scales. *Sewickly Coal*, 4 to 4½ feet; Soft blue Shale, 2 feet; Yellow Limestone, 6 feet; Yellow and bluish Shale, sometimes silicious. *Redstone Coal*, from 1 to 2½ feet; Blue Slate, with calcareous nodules, 15 feet; Micaceous Sandstone, 5 feet; Black and brown Shales, 15 feet. *Pittsburg Coal-bed*, lower member, 10 feet.

The Pittsburg Coal-seam itself exhibits at Mr Brownfield's bank the following upper members:—

Brown Slate, 5 feet; *Coal*, 2½ feet; *Slate* and *Coal* in thin alternate layers, with a few small nodules of iron, 15 inches. *Coal*, 1 foot; Dark-blue Shale, 1 foot. *Coal*, 12 inches; Blue Slate, 3 inches, and thin lower member.

The third coal-bed of the column (Fig. 504) is mined at Uniontown, and elsewhere in the neighbourhood, and yields a solid good coal, as at the mouth of Shute's Run. In some places its amount of contained sulphuret of iron is

less than at others. By the height at which the plane of this coal-bed lies above that of the Pittsburg Seam, it will be seen that, to reach the latter at Uniontown would require a shaft about 210 feet deep.

The section of the rocks above this seam was compiled from obscure exposures upon the higher hills, and does not exhibit the character or thickness of the strata with much accuracy: it must be regarded merely as an approximation to the truth. The local bed marked 15 inches is opened some distance N.W. of the town, and yields at that point nearly 2 feet of good coal. The three thin coal-seams still higher in the series are exposed by such of the roads as cross the highest hills near Uniontown, and appear to be but a few inches thick. Whether one of these is the 5-feet bed mentioned before, as opened at Cox's or Gilcrease's openings, has not been determined; but the probability is, that the hills where it occurs, 6 miles to the N., are much higher than those about Uniontown, though the basin itself seems to deepen S.

The Redstone Coal-bed, 2½ feet thick (shown in Fig. 505), is seen decidedly marked, and with definite relations to the coal-beds above it and below it. It is opened 2½ miles S.W. of Shute's Run. It is 45 feet above the Pittsburg Coal, and 48 feet below the Sewickly Coal. The latter bed is here irregular in its thickness; it contains sulphuret of iron, and has resting immediately upon it an irregularly stratified coarse-grained sandstone, instead of a regularly-deposited limestone, as in some other localities. The sandstone is full of wrinkles, breaks, and thin flakes and layers of coal, in wedges and chips, exhibiting most strikingly the violence of the action upon the coal-bed previously deposited, of the agent which produced the layers of the sandstone. Without comparing the two vertical columns, the coal-bed would never be suspected to be identical at the two localities.

The space (110 feet) was estimated from imperfect data, and probably is not by any means so great; it contains much limestone.

The layers of this great mass of limestone form, for several miles, most of the steep cliffs along the banks of the Redstone Creek.

9.—PITTSBURG COAL-BED SOUTH-WESTWARD FROM REDSTONE CREEK.

The Pittsburg Coal is opened upon its E. outcrop, at no great elevation above the water, on the land of Mrs Sutton; also on Mr Brownfield's, at one of whose openings the irregular deposition of coal and slate in the upper member of the bed, 5 feet in thickness, is very visible (see Fig. 505). One mile S. is another opening, then another at the base of gentle hills, overlooking a wide flat to the E.

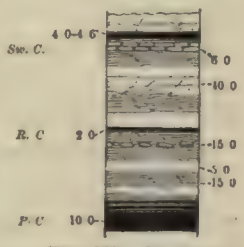


Fig. 505.—Redstone.

The ore smelted at Oliphant's furnace was formerly obtained at Mr Wynn's bank. Here the bed is 7 feet thick in its lower member; floor, blue slate, 4½ feet thick; then fire-clay, 1½ feet thick; then a stratum of ore varying from 2 to 8 inches; this is again underlaid by blue slate.—(See Fig. 506.)

This excellent iron-ore is obtained from numerous openings between Redstone and George's creeks, in roundish discs or cakes, traversed by numerous white veins of crystalline structure; it is of a blue colour, and of fine-grained compact structure. The ore is said to have been found at Mount Braddock; and, doubtless, examinations very easy to be made would greatly enlarge the area over which it may be profitably wrought. It is not seen, however, on the Youghiogheny, where sections have been made of all the rocks immediately under the great bed of coal.

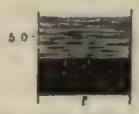


Fig. 506.—Oliphant's Furnace.

To the S. of Oliphant's furnace the Pittsburg Seam continues to recede from Chestnut Ridge, and to rise in the side of its own range of hills. It is opened one mile beyond the furnace. At Smithfieldtown its outcrop is two miles from the ridge, and has been repeatedly wrought. Thence the margin of the coal skirts the valley of George's Creek, following its Northern edge Westward, even across the first sub-axis into the second sub-basin. It is seen in the high knob between the forks of George's Creek.

South of George's Creek, along its E. outcrop, the Pittsburg Coal-bed is first opened one mile from the ridge, and separated from it by a wide valley of denudation. At the next bank (Mr Davis's) the coal is found to contain a quantity of sulphuret of iron and layers of slate. Each of these features is quite foreign to the bed in

the country hitherto described. The sulphuret of iron occurs in flattened nodules, from 3 to 8 inches broad, and from 1½ to 3 inches thick.

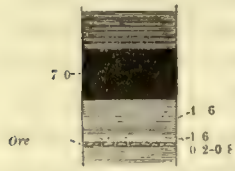


Fig. 507.—Virginia Line.

The coal is opened at intervals of half a mile by Messrs Morgan, Burchinel, and Sines, where the coal is 6½ feet thick; farther on, by Messrs Sturm, Waltg, and Morris, the last-mentioned within half a mile of the Virginia line. At all these points the openings are made high up on the hills. At Mr Rubble's bank, a quarter of a mile S. of the State line, the bed yields but 5½ feet of coal, with a few slate intercalations; roof of upper member, brownish slate, 6 feet, and above this coarse grey sandstone, 8 or 10 feet exposed (see Fig. 507).

The ore-band has here been wrought for Duncan furnace. The coal-bed itself occupies a long narrow area, at the summit of a ridge between the valleys of the Cheat River and McCulloch's Run. On the S. side of the Cheat River, an opening upon the Pittsburg Coal-seam, near the Morgantown Road, one mile W. of McCulloch's Run, exhibits an unpersistent interstratum of slate, 10 inches thick 1 foot from the floor of the bed, and 8 feet from the roof. At another opening 9 feet of coal are overlaid by 1½ feet of blue slate, and above this there occurs a thick irregularly-stratified coarse-grained sandstone (see Fig. 508). The plane of the bed is near the top of the river-hills, which are from 300 to 400 feet high. At the mouth of the Cheat River the elevation of the outcrop-level is 371 feet.

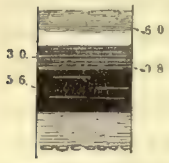


Fig. 508.—Cheat River.

On the N. side of the river it is opened at eight or ten localities, by various persons, to within 2 miles of the mouth of the river.

The vertical section of the strata of this vicinity, given in Book X. Chapter II. (see Section N.W. side of Laurel Hill, Cheat River, Virginia), constructed by Professor W. B. Rogers, is presented to show the relations of the Pittsburg Seam to the other strata as they are exposed in the gap of the Cheat River.

The openings upon the Monongahela River will be described hereafter, in following the course of that stream to Pittsburg.

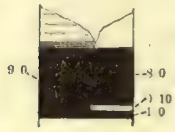


Fig. 509. — Cheat River, Laurel Hill Gap.

Over the whole space bounded by the Monongahela and Cheat rivers and George's Creek, the Pittsburg Bed spreads in a nearly horizontal plane, and at a great elevation above the general water-level. It has been said that the height of this plane above the Monongahela Bed, at the mouth of Cheat River, is 371 feet; upon George's Creek, at its lowest probable point, it is 173 feet above the bed of the creek. The basin itself seems to rise S.W., so that the lowest point reached by the coal-bed on Cheat River is about 250 feet above the water. The relation of water-level at the three points was not measured.

The Pittsburg Coal-bed over this area not being covered by any great thickness of the upper series, is developed by all the streams and ravines of the country, and extensively mined by the inhabitants. The following openings along George's Creek, on the S. side, appeared at the time of our survey. Proceeding W. from Brown's bank, before mentioned, were T. Slenty's, Smith's, Long's (173 feet above the creek at Long's mill), containing many nodules of sulphuret of iron; Griffen's, Harden's, A. Oliphant's, G. Genty's, Crow's, Schwenzger's, Fate's, Ross's, within a mile, and Frank's, close by New Geneva.

Upon the N. side of the creek were Sutton's and Rumble's banks, opposite Long's, and below W. Griffen's, D. Brown's, Dill's, Word's, and Philip's, a mile and a half from New Geneva. This is about upon a line with the first sub-axis.

Below New Geneva, along the river, the bed is seen at the mouth of Cheat Run, still above water-level, but below that point it dips beneath the bed of the river.

10.—PITTSBURG SEAM, UPON THE FIRST SUB-AXIS, BETWEEN REDSTONE CREEK AND GEORGE'S CREEK.

It will be more convenient to take this region into consideration, before proceeding to the systematic description of the upper Coal-measures found in the second subdivision of the Third Basin, to which it properly belongs.

Upon the Redstone Creek, and on the E. side of the first sub-axis, the Pittsburg Coal-seam rises from the bed of the creek 2 miles above Middletown; it is quarried on the W. bank by Messrs Gaddis, Gibson, and Swan. Half a mile S. of the last is Mr Springer's coal-bank on the National Turnpike, near the second milestone.

South of the National Turnpike the Pittsburg Coal is opened successively, upon its W. outcrop, by Mr Jeffers (coal 9 feet thick, and 70 feet above water-level); Ebhard Wood, 1½ miles from the turnpike; and Vankirk, W. of which, at the summit of a high hill upon the line of the sub-axis, the bed is seen nearly horizontal. This point is a fourth of a mile N. of the McClellandtown and Uniontown Road, and the most N. locality, upon the first sub-axis, at which the Pittsburg Bed is seen. It is about 2 miles to the S. of the National Road. To the S. of this knob the bed has been swept away for a narrow space along the axis, the outcrops running nearly parallel, and meeting again farther to the S.

Upon the E. outcrop of the Pittsburg Seam, on the W. side of the sub-axis (corresponding to its W. outcrop on the E. side of the axis), are numerous openings S. of the National Road.

Half a mile E. of McClellandtown, the Pittsburg Coal-bed sinks beneath the water-level upon Brown's Run. It is opened by several persons within 2 miles S.W. of this; and between this and the Masontown Road there are numerous openings at different elevations.

On a branch of Cat Run, and half a mile E. of Masontown, an exposure of the bed shows a change of character in the associated rocks (expressed in Fig. 510); we have,—

Limestone at the bank of the run, 4 or 5 feet; a few feet above the limestone, *Coal*, 8 inches; Brown Shale, some layers silicious, 22 feet; to the Pittsburg Coal, disappearing beneath the run at the base of the hill on which Masontown is built. From a large flat here, great quantities of coal have been taken on the land belonging to Mr Rider. *Coal*, 8½ feet thick, full of sulphuret of iron, and thin slaty layers; Blue Shale, from 12 to 18 inches; Thin solid layer of thin carbonaceous Slate, with polished planes of cleavage; Black Slate, 18 inches; *Coal*, 2 feet; Slate; Sandstone.

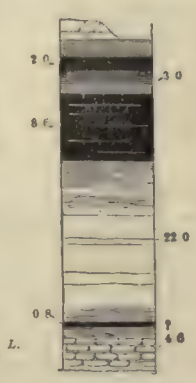


Fig. 510.—Cat Run.

Farther down Cat Run, at Johnson's mill, the coal-bed is 8 feet thick.

From the openings upon Cat Run E. the Pittsburg Coal-bed has a gentle rise until it surmounts the axis; it is frequently opened high on the hill, not far W. of the axis, where the coal is 9 feet thick, with thin slate-layers interlaminated with the thicker bands of coal: roof, blue slate and coal, 2 feet.

The Pittsburg Coal occupies a range of higher hills upon the sub-axis, between which denuding forces have swept it away, with the rocks beneath and above it, and over so large an area that a comparatively small quantity of the bed remains. The openings are consequently few; more of them are seen upon the road that crosses the axis just N. of George's Creek than elsewhere. But on its E. slope, beginning with the last-mentioned opening, we have a number of openings in tracing its W. outcrop. One of these, high upon the axis, shows—Coal, 7½ feet; sandstone and shale, 2 feet; slate and coal, 4 feet (see Fig. 511). It is seen at Showalter's, Smith's, Deiffenbaugh's, Huston's, Patton's, and Bowell's. Again at Smith's, 2½ miles W. of Oliphant's furnace, Comb's, McCormick's, Freeman's, Sturgi's, and Anderson's. At several of these banks the Oliphant furnace-ore has been obtained from beneath the coal. Some of the openings are in the synclinal trough. Many exposures of the Pittsburg Coal-bed are afforded by the deep trench of York's Run.

Fig. 511.—Newcomer's.

Many other openings are made in it in the neighbourhood of Smithfield; at these some interesting metamorphoses are exhibited in the structure of the bed, one of which is represented in Fig. 512, constructed from observations made at two openings, only 400 yards apart. One exhibits 6 feet of coal, with thin slate-layers as the lower member, and immediately upon it 6 feet of slate, with irregular layers of coal; roof slate, and sandstone over all. At the other we see 4½ feet of coal, with thin layers of slate,

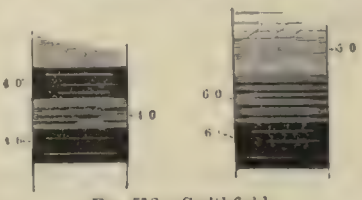


Fig. 512.—Smithfield.

as the lower member; 4 feet of black and blue slate, with layers of coal between, as the middle; and 4 feet of coal, with slate in thin layers, as the upper member. At one place there is quite a thick stratum of slate in the midst of the lower member.

11.—ROCKS ABOVE THE PITTSBURG COAL, SOUTH OF REDSTONE CREEK.

The columns already presented (Figs. 503, 504) give the series of strata above the Pittsburg Coal-bed, as far as discoverable upon Redstone Creek.

The first (*Redstone*) coal above the great seam has nowhere been seen by us in the country to the Southward of the stream.

The *Sewickly Coal-bed* is opened, with a thickness of 4 feet, upon Messrs Brownfield's and M'Kee's lands, and frequently exhibits its outcrops farther Southward. To the S. of George's Creek its has doubtless been wholly denuded from the surface. S. of the Cheat River it again appears.

Along its W. outcrop it has been mined by Mr Brown at a spot 4 miles to the S.W. of Uniontown, and is 5 feet thick; again, half a mile S. of this, it is from 4 to 5 feet thick; its smut is seen in places farther S., nearly to George's Creek.

A large stratum of grey sandstone, coarse-grained and micaceous, and frequently of considerable thickness, is observed to accompany the Pittsburg Coal in this part of the region, and especially where it arches over the sub-axis. This sandstone is the equivalent of the Pittsburg Sandstone, as shown in the earlier vertical columns illustrating the Conemaugh and Loyalhanna districts. The summits of the hills between George's Creek and the Cheat River are frequently capped by this sandstone and its accompanying slates, with an occasional stratum of limestone; hence the absence of the Sewickly Coal-bed.

The *Great Limestone* formation, with its accompanying shales, rises gradually along the E. and W. sides of the chain of hills in the centre of the trough, from the latitude of Uniontown southward. These hills are none of them very high, and the limestone soon forms their summits, until at George's Creek they are no longer of sufficient height to receive even its lowest members. But passing to the S. side of the creek, a limestone-bed is sometimes found at the tops of the highest knobs, which may be a relic of the great calcareous stratum.

The outcrop of the Uniontown small double *coal*, of Fig. 504, is occasionally seen Southward of that town, but it has nowhere been drifted in upon. Upon Judge Irving's land, near Uniontown, is an opening upon a 3-feet bed, full of slate and sulphuret of iron, and underlaid by 15 feet of rocks, at the lower limit of which is a bed of pure limestone 4 or 5 feet thick. This bed may possibly be the *Uniontown Coal*, which, however, has a limestone-bed immediately beneath it, as well as one at some distance.

The rocks overlying the Uniontown Coal-bed are not widely spread Southward from the National Road. One or two of the coal-beds of this part of the series, whose outcrops are noticed in the hills N. of Uniontown, occur in the highest summits S. of the National Road.

At the second ascent upon the Morgantown Road, in going Southward from Uniontown, there are exposures in the ascending order of dark-brown sandstone and olive slate. This bed of coal may be identical with the 15-inch seam shown in Fig. 504; it yields a light soft crumbling coal, and is near the summit of a hill in the central line of the basin.

Above this highest coal-bed are seen a few impure calcareous layers, found only as fragments upon the surface.

CHAPTER XXVI.

1.—SECOND SUBDIVISION OF THE THIRD COAL-BASIN WEST OF THE FIRST SUB-AXIS, S. OF THE CONEMAUGH—UPPER GROUP.

THE upper coal group, based upon the Pittsburg Coal-bed, has a narrow range in the second subdivision of the third great basin, being confined to a canoe-shaped trough along its medial line, the Northern

termination of which is visible a few miles N. of New Alexandria, and the Southern about 3 miles S. of Greensburg. Even at its deepest part this trough of upper rocks contains only an inconsiderable thickness of strata.

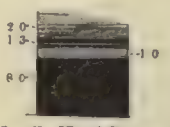
The Pittsburg Coal-bed, whose outcrop limits the area, has been greatly denuded from the E. side of the sub-basin. In that part which lies to the N. of the Loyalhanna, it makes its first appearance at the summit of a knob 3 or 4 miles N. of New Alexandria, and a short distance Westward of the Pittsburg Turnpike. At a point S. of this it is opened 8 feet thick, and exhibits its double structure of upper and lower members, as in the previous sub-basin, to the E. It follows a narrow irregular belt, sinking gradually with the sub-basin to the Loyalhanna, where it occurs still high upon the hills near the village. The bed has not been discovered in any of the hills N.E. of it, although they seem high enough to contain it.

The Pittsburg Coal-bed has been opened at about one mile Southward of New Alexandria, upon the W. side of a hill, upon the E. slope of which the outcrop appears. Several openings have been made upon it in the ravines of runs still farther South, as at Barnett's mill and Millar's bank, about 2 miles distant from Greensburg, and 400 yards N. of the Greensburg Turnpike Road. Here the lower member of the bed is 8½ feet thick, the upper member 3 feet. It is cut at George's Summit on the Pennsylvania Railroad, and is mined on the turnpike at its E. outcrop; and again one mile N. of Greensburg, where the lower member is 8 feet thick; overlaid by blue slate, 1 foot; coal, with slaty layers, 15 inches; upper member, coal and slate in confused layers, 2 feet. The bed dips N. a few degrees W., the basin rising Southward.—(See Fig. 513.)

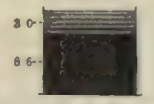
FIG. 513.—Pittsburg Coal.

1 mile S.E. of Greensburg.

1 mile S. of Greensburg.



1 mile N. of Greensburg.



Millar's Bank, 2 miles from Greensburg.

At another opening, one mile S.E. of Greensburg, the lower member measures 7 feet in thickness; dip steep to the N.W. One mile S. of Greensburg the bed is opened on both sides of the valley of the Sewickly. It measures here 7½ feet, lower member; upper member 4 feet. One and a half miles S. of Greensburg it is 25 feet above water-level. At Mr Hammer's bank a transverse roll has thrown the bed into some irregularities of aspect, dipping it rapidly to water-level Southward, and bringing it up again with a steep counter-dip. At Shaeffer's opening it is pretty high upon the hills, and nearly horizontal. At Bear's Bank it outcrops at the S. end of its area.

Upon its Western outcrop, S. of the Loyalhanna, the Pittsburg Coal-bed is opened at the creeks, and also on the turnpike one mile W. of New Alexandria. It is here 8 feet thick in its lower member; again on a high hill E. of the White-Thorn branch of Beaver Dam Run; at Kipple's mill, where it yields 6½ feet of coal; on the Greensburg and Freeport Road; at the railway tunnel, about one mile W. of Greensburg; again, 300 yards S. from the turnpike, the coal is from 6½ to 7 feet thick (dip E. 20° S.; upper members, blue shale, 10 inches; coal and slate, 15 inches; coal, 15 inches; dark olive shale); also one mile from the turnpike, and elsewhere.

The area occupied by the Pittsburg Coal-bed has thus a width which varies from a few hundred yards to 2½ miles.

2.—ROCKS ABOVE THE PITTSBURG COAL-BED, SECOND SUBDIVISION OF THIRD BASIN.

A few layers of dark-olive slates and grey micaceous sandstone have been left resting upon the Pittsburg Coal-bed N. of the Loyalhanna. The Pittsburg Sandstone does not present itself here with such decided characteristics as in the first subdivision of the basin.

South of the Loyalhanna, the section of rocks superposed upon the Pittsburg Coal-bed (expressed in the annexed column, Fig. 514) is of greater vertical thickness; but no opportunities for examination were afforded to any satisfactory extent except along the transverse valley of the Loyalhanna, where that section was constructed or collated from road-diggings, some quarries, and a few small natural exposures: hence it cannot be relied on further than as a general exhibition of the contents of the trough, irrespective of their precise mutual

relationships, as elsewhere it was found impracticable to identify the beds of slate and sandstone found here. The section reads as follows, from above downwards—(See Fig. 514) :—

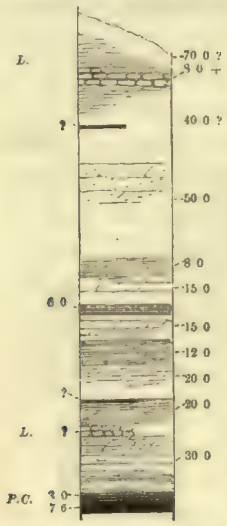


FIG. 514.—Loyalhanna, New Alexandria.

Sandstones and olive Slates, the summits of the hills. *Great Limestone*, in thick massive strata, 8 feet; exposed on the Loyalhanna, but fully developed by the tunnel and cuttings of the Pennsylvania Railroad, at and near Greensburg, 30 to 40 feet. Interval, containing a thin coal-outcrop, 40 feet. Sandstone in flags and massive strata, 50 feet; Yellow Slate, 8 feet; Coarse grey Sandstone, 15 feet. Blackish Slate, 6 feet; place of Sewickly Coal (?) Micaceous Sandstone in thin layers, 15 feet. Black Slate, with sandy layers, 12 feet; Brown Shale, 20 feet. *Coal* outcrop; Redstone Coal-bed (?) Yellowish and bluish Shale, with thin limestone layers in the lower part, 20 feet; Silicious Slate and flaggy sandstone, 30 feet. Pittsburg Coal-bed—upper member, Coal and Slate, 3 feet; lower member, 7½ feet.

The uppermost bed of the great calcareous deposit is sometimes quite a pure and fossiliferous limestone, in thick layers; it is found at the tops of many of the central hills—for example, it has been quarried at the summit of one a little East of Greensburg. Another and lower limestone, the precise place of which could not be determined in the section, repeatedly appears at the base of such hills as exhibit the upper limestone-stratum at their summits.

The Sewickly Coal-bed only indicates here its proper position by black slate, although it is well developed S. of this upon the Sewickly Creek.

From the S. point of the Greensburg area of the Pittsburg Coal, to New Staunton on the Big Sewickly, nothing is to be seen but the Barren Measures, which afford occasional traces of a coal-bed upon their hill-sides.

CHAPTER XXVII.

ALLEGHANY AND MONONGAHELA RIVERS, IN THE NEIGHBOURHOOD OF PITTSBURG.

DESCENDING the Alleghany River from the mouth of the Kiskiminetas, we meet with the rocks in an ascending order, the upland on each side being occupied by the Barren Measures.

The Lower Freeport Coal, 57 feet above the water at *Freeport*, gradually subsides to the level of the river, which it reaches at about 2 miles above Tarentum, varying in the interval between a maximum thickness of 4 feet and a minimum of 2 feet.

The Upper Freeport Coal, after being exposed by various cuttings of the Alleghany Valley Railroad, disappears beneath the water-level 3 miles below Tarentum; near which it is mined at an elevation of 30 feet, though it shows itself on Pine Creek, about 2½ miles from the river, exactly on a level with the stream. It is here 6 feet thick. At Peterson's salt-well, one mile below Tarentum, it is of the same thickness, being opened beneath a bed of shale, at an elevation 25 feet higher than at half a mile farther down the river. At Kier's salt-well, a short distance above, it is 7 feet thick, and is mined 40 feet above the level of the river. At Tarentum it is opened at Donnelly's salt-well, and in several other places on both banks of the river, within 3 miles of which it is also mined on Bull Creek. At Freeport it is 144 feet above the water.

The Freeport Limestone, though often regularly stratified, consists more generally of a stratum of nodules imbedded in shale, but even these yield a good ash-coloured lime.

Below the town of Freeport, between the Mahoning Sandstone and the Upper Freeport Coal, there lies a mass of shales from 2 to 20 feet in thickness.

The Mahoning Sandstone forms a double set of cliffs along the river-slopes from Freeport to Tarentum. It consists of two massive members, each 35 feet thick, and separated by 25 feet of shale. A band of quartzose conglomerate, 4 feet thick, occurs at the base of the upper member, imbedding nodules of iron, and sometimes overlying a 6-inch bed of slaty coal, which is to be considered as the representative of the Elk-Lick Coal-bed.

PITTSBURG IN 1840, FROM GRANT'S HILL

The rock forms much of the surface-land of the S. parts of Armstrong and the N. parts of Alleghany counties.

A second Barren-Measure Coal-bed, to which we give no name, overlies this Mahoning Sandstone in the river-hills, 15 miles above Pittsburg (compare Fig. 394, at Alleghany Furnace), and is 1 foot thick. It traverses the N.W. corner of Westmoreland County.

Above it are yellow and brown shales, which graduate upwards into a mass of slaty argillaceous sandstone, forming at Sharpsburg the lowest rock seen at water-level; it is well exposed at the mouths of Cirtie's Run and Pine Creek, and in most of the ravines between Pittsburg and Tarentum. It also appears at the mouth of Sawmill Run upon the Ohio River.

At Pittsburg we find, at the base of the hills which overlook the city, a bed of variegated calcareous shale, of a peculiar mottled appearance, its lower portion reaching down nearly, if not quite, to the brink of the Ohio River. It is a bed of considerable thickness, and consists of two varieties, the one blue and the other bright purple or red, irregularly intermixed in spots, blotches, and bands. The blue variety lies sometimes in continuous layers. It is soft and calcareous, sometimes without any regular cleavage, and exists throughout as a rather homogeneous mass, very friable, and easily crumbled by the weather. Dispersed through it are numerous calcareo-ferruginous concretions lying in irregular layers, and occasionally so abundant as to constitute a considerable part of the whole bed. They are of all sizes, more or less ferruginous and excessively hard. Some minute fossils have been detected in this stratum, but it is generally not fossiliferous. The quantity of calcareous matter diffused through the shale is such, in fact, as to warrant our considering it an impure *marl*. From Pittsburg it may be traced along the W. bank of the Alleghany River to some distance above Sharpsburg, rising N. On Thompson's Run, a branch of Turtle Creek, 14 miles E. of Pittsburg, it is met with, forming the base of the hills at nearly the same elevation as at that city.

The coal of the Barren Measures resting on the above is a thin seam varying in its thickness from 6 to 18 inches, and of good quality. It is hard, black, and brilliant. One foot is about its average thickness.

Black Fossiliferous Limestone.—This is a dark-grey or black limestone; when first exposed it is extremely hard, effervesces freely when treated with an acid, and is remarkable for the abundance, though not the variety, of the fossils diffused through it: these are principally bivalves, species of Producta, Leptena, Terebratula, &c. Joints of Encrini are also very abundant, from one-sixteenth to half an inch in diameter, the column being composed of crystallised carbonate of lime, which has a handsome appearance when freshly broken. Another very abundant and characteristic fossil is a species of Orthocera, from half an inch to two inches in size, often abundant on the surface of the rock. Ammonites have also been found in it. When exposed near the base of the hill, this stratum forms a shelf above the small coal-bed; it is of a brownish-grey colour, and outward slaty structure. If judiciously selected it will make a good lime, and has been used for the purpose on the Mechanics' and Farmers' Turnpike at Pittsburg. In company with the preceding strata, it rises to the N. along the course of the Alleghany River. It has been detected in Indiana, Wilkins and Versailles townships, Alleghany County, and in Washington and Unity townships, Westmoreland County, and on the Kiskiminetas, below Saltzburg. Thickness about 2 feet.

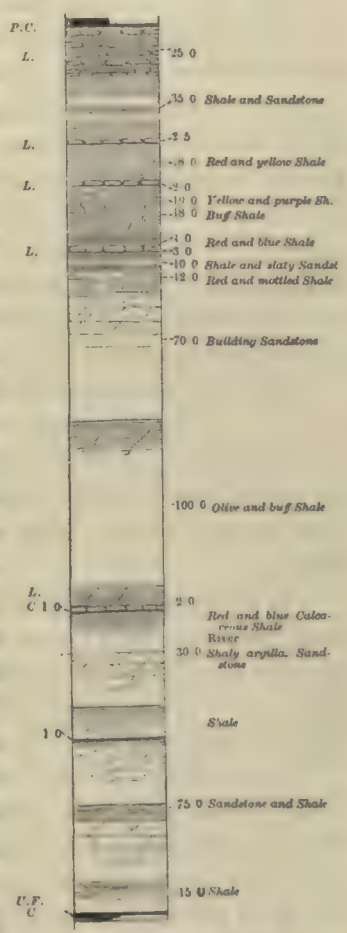


Fig. 515.—Type of Strata at Pittsburg.

The next stratum ascending is a heavy deposit, consisting of shale, passing into slate, with sandstone layers. The lower portion is a soft shale of a drab or yellowish colour, regularly laminated, and decomposing into a stiff clay. Nodules or concretions of compact, fine-grained, and tolerably pure limestone, are dispersed through it. It passes into a heavy slate of blue, yellow, and black colour. It is slightly micaceous, contains a good deal of sand,

and splits into plates, somewhat resembling roofing-slate. Upon this, in some places, there is a thick bed of slaty sandstone, passing gradually into a smooth slate. The sandstone layers are sometimes very compact and heavy, at others separated by bands of shale. The dark-coloured portions of the stratum are generally fine-grained, have a ready cleavage, and contain impressions of plants. Plates may be obtained 2 feet square, beautifully marked with these remains of an ancient vegetation. These are not found in the hard silicious upper layers. The whole mass is sometimes divided in a vertical direction by joints, which separate it into prismatic blocks, and impart a picturesque appearance to the exposed portions. Layers of calcareo-ferruginous concretions are found running through it parallel to the cleavage. They are generally round and rough or knotty on the surface, and from 2 to 4 inches in diameter.

The upper part of this bed, immediately beneath the overlying stratum, differs frequently in appearance from the rest. It is much softer, is red or yellow in colour, and slightly ferruginous. The hard silicious portions afford an abundant supply of good flagstones. The dark black bands have been mistaken for the soft shale accompanying the coal.

This member of the series may be traced generally along the watercourses throughout Alleghany County, and is exposed in Unity and Franklin townships, Westmoreland County. Thickness by estimation, 100 feet.

Grey Sandstone.—Upon the above there rests a valuable and important deposit of sandstone. The lower portion is very solid and compact, affording an excellent material for building, while the upper portion is generally too slaty and too much broken to be used for this purpose. The prevailing colour is a light grey, with a yellowish tinge; in some places it is brown and brownish green. It varies in composition as much as in colour, but generally admits of being easily dressed, and of being readily split into prismatic blocks. Some portions are remarkably micaceous, in others the mica is entirely wanting. Occasionally it is not fit for masonry, being too friable, and crumbling too freely on exposure to the atmosphere, chiefly in consequence of its containing in these cases a considerable proportion of clay. In this rock the lines of deposition are very manifest, forming beautiful curves, and accurately representing the eddying currents by which the fine sand was originally deposited: these are most evident where a brown layer interposes itself between the lighter-coloured rocks. Imbedded in the lower parts of the mass are great quantities of pebbles, which differ in colour and composition from the material of the surrounding sandstone; they consist generally of a drab or a bluish-coloured clay of a fine texture, and contain minute specks of mica; they are from 1 to 15 inches in diameter, but always rounded, and apparently water-worn. The question of their origin suggests some interesting inquiries.

The lower part of the stratum contains also thin seams of vegetable remains. These fill the joinings of the layers, and are composed of black carbonised matter, which in some instances assumes the condition of a pure coal. They are slaty, friable, and emit a bituminous odour when freshly broken. These impressions are generally so interlaced and compressed together, that it is difficult to distinguish their forms; now and then, however, distinct figures are traceable from 6 to 8 inches broad, and with curved stems of considerable thickness.

In many situations this rock is soft, crumbly, and granular, consisting of rounded grains of sand of a dark green, and sometimes a brown colour, passing into a ferruginous reddish tint. This change of colour depends upon the quantity of iron present in the rock, and the stage of decomposition to which it has arrived. The grains are of pure white quartz, evidently water-worn, and united by a calcareous cement, particularly in the green and brown varieties. In the former, some minute fossil univalve shells have been detected.

This rock is sometimes met with in a state of complete decomposition in the form of a coarse sand. Certain layers are yellow, others bright red, with intervening layers of grey sandstone, which, containing but little iron, have resisted decomposition. In these cases the thin flakes of the vegetable remains have been replaced by layers of black clay and sand; the rock in this state is too friable to admit of being transported. The upper part of the main stratum into which the preceding passes, is generally very schistose, with irregular laminations, and presents a broken, shattered appearance; it is sometimes very full of nodules, which are chiefly concretions of an impure iron-ore. This stratum affords an abundant supply of building-stone to the city of Pittsburg. The sandstone employed in the construction of the court-house, the Western Penitentiary, and other

public buildings, and also some private edifices, belongs to this member of the series. It is quarried in many places on the Monongahela, along the banks of which it may readily be traced, until it sinks below the water-level. Medium thickness, 70 feet.

Red Shale.—This is a bed of red and marly shale, internally blue and mottled, resting on the schistose part of the preceding stratum, and forming in the hill-sides a well-defined belt of a bright red or purple colour. It is in general imperfectly laminated, slightly calcareous, and contains traces of fossil shells. It is not exposed on the hills immediately around Pittsburg, but may be observed on the level or slightly undulating flat upon which East Liberty is situated. It extends widely through Alleghany County. The thickness averages 12 feet.

Above the red-shale stratum are blue or yellowish-green slates marked with ferruginous discolorations, and also layers of sandstone. Where these predominate, the rock is a coarse slaty sandstone. Thickness, 10 feet.

Non-fossiliferous Lowest Limestone of the Barren Measures.—This is a well-defined stratum consisting of a hard yellowish or buff-coloured limestone, jointed into square blocks. It effervesces freely, gives out an argillaceous odour, and is marked with transparent specks of crystallised carbonate of lime. It probably contains too much oxide of iron and argillaceous matter to yield a good lime. For weight and hardness it is quite remarkable. Although frequently exposed along the hill-sides, it is not easy to trace, as it is very apt to be covered up by the matter from the overlying shales. Thickness, 3 feet.

Upon the limestone rests a stratum of red and blue shales, distinguished by its want of tenacity, its bright colours, and smooth cleavage. The red and blue portions are irregularly intermixed. This is one of the coloured shales which give the red and variegated appearance to the lower part of this series, and may be met with on the sides of the hills and ravines throughout Alleghany and the N. part of Westmoreland counties. Around East Liberty this and the next stratum are found on the surface of the remarkable flat on which that suburb is situated, in many places decomposed, and forming a red soil. Thickness, 4 feet.

Above the red shale are buff and olive shales, 18 feet thick; still higher, yellow and purple shales. The lower portion of these is frequently of a dark purple colour, and is very soft and not well laminated. The prevailing colour is yellow. They are frequently exposed on the sides of the runs and watercourses. Calcareous nodules are scattered through them, sometimes constituting the largest portion of the stratum. Thickness, 10 feet.

Second Non-fossiliferous Limestone of the Barren Measures.—Upon the preceding is a thin bed of limestone resembling that last described in appearance and composition. Blocks of it are frequently scattered along the base of the hills, having fallen down from the washing away of the underlying bed of shale. Thickness, 2 feet. Over it lie red and yellow shales, soft and friable, and containing a few calcareous nodules. Thickness, 12 feet.

Third Non-fossiliferous Limestone of the Barren Measures.—This is a conspicuous and widely-expanded bed of limestone, from 3 to 5 feet in thickness; it is yellow on the surface, though internally its colour is dark blue. It breaks off in square or oblong blocks, which are hard and heavy. Portions of it might perhaps receive a good polish. By the decomposition of the underlying shales, it is often found tumbled down at the base of the high hills which enclose the Monongahela and Youghiogheny rivers, along whose shores its fragments are abundant.

Over the limestone occurs a thick and important deposit of shale and sandstone, extending up to the next bed of limestone, or that which underlies the main Pittsburg Coal-seam. It is perhaps 30 feet thick. It may in almost all cases be seen where the coal itself is exposed, generally in the character of a grey slate, well laminated with interspersed sandstone layers, varying from a few inches to several feet in thickness, and separated by soft bands of shale. The upper part of this stratum adjacent to the limestone is frequently very soft and friable, abounding in calcareous nodules, irregularly dispersed throughout the mass. Occasionally, but not very often, the sandstone layers increase in number and thickness with a corresponding diminution of the shales, giving rise to a sandstone sufficiently compact to be employed in building. It is quarried for this purpose in the vicinity of Pittsburg, though more usually its principal useful application is in supplying much excellent flagstone, which it readily affords, of large size and very smooth surface. This stratum extends through the valley of the Monongahela from the foot of Chestnut Ridge to the W. boundary of the State, obeying the

general inclination of the accompanying strata, and exposed in corresponding situations. The sandstone layers very frequently exhibit "ripple-marks," disposed with great regularity, showing that the rock was deposited from a rather gentle current, and probably in a shallow sea. Impressions of plants are not uncommon. Thickness by estimation, 30 feet.

Pittsburg Limestone.—Resting on the above, and immediately underlying the Pittsburg Coal-seam, is a bed of blue and black limestone, in layers from six to ten in number, separated by shale, the whole measuring about 25 feet. One of these layers is generally found immediately under the coal-seam, succeeded by the principal body of the shale, beneath which are the remaining layers of limestone in a close and continuous stratum. These layers are from 1 to 2½ feet in thickness, and vary in their colour, which is generally dark blue, though in some cases it is a deep black, and then the rock is ferruginous, and gives out a bituminous odour. When there is a deficiency of calcareous matter, the upper layer adjacent to the coal-seam is wanting, and its place is supplied by a layer of excessively hard calcareous nodules called "Nigger-heads" by the miners, and which are imbedded in the usually intervening shale.

Pittsburg Coal.—This consists of three parts: first the main breast of coal, and above this a layer of clay, and over this again a bed of coal, forming the roof. The former of these rests upon the limestone, from which it is generally separated by a few inches of blue clay or decomposed shale.

In the neighbourhood of Pittsburg the lower part of this mass, for about 1 foot in depth, abounds in thin seams of pyritous shale, and is hence rejected by the miners. Above the main seam there is a stratum of blue or black clay-shale, dividing it from the coal roof. It is hard and compact when first dug out, but on exposure to the atmosphere crumbles down into a soft clay. It is generally free from gritty particles, and has, with a similar layer in the coal next the roof, been advantageously used in the manufacture of fine bricks. Above it is the roof coal, consisting of a bed of coal with shale intermixed in numerous thin layers. Towards the bottom this is a band of true coal from 1 to 2 feet thick; the higher layers are generally thin. The coal in this part of the seam is in itself of good quality, but the expense of separating it from the accompanying slate is generally too great to justify the attempt: hence the miners along the Monongahela content themselves with extracting the lower division, leaving the remainder to form the roof of their drifts. In Alleghany County the main breast varies from 5 to 6 feet in thickness. The quantity of pyrites in the clay and shale accompanying the coal is very considerable; these layers readily crumble, and when exposed to the atmosphere are generally covered with *copperas*, produced by the chemical action upon the sulphuret of iron. These natural encrustations of copperas are very common throughout the district. In many instances the coal of the roof has been precipitated, by a slipping of the hill-side, upon the lower part of the seam, in which case the latter has often taken fire from the heat evolved by the chemical decomposition just mentioned. This has occurred particularly at the mouth of Redstone Creek, in Fayette County, where the overlying shale has been baked and reddened by the combustion, and hence the name of the stream. The shale and clay of the upper part of the seam abound in casts and impressions of plants, many of which are very beautiful.

The Northern outcrop of the Pittsburg Coal is about 5 miles N. of Pittsburg, passing through the highest hills in the N. parts of Westmoreland County and that part of Beaver which lies S. of the Ohio River. In the neighbourhood of Pittsburg, the coal at the summits of the hills is overlaid by a bed of brown friable and compact shale of a ferruginous appearance, enclosing sandstone layers of greater or less thickness, which, increasing, as we ascend, in number and size, pass gradually into a compact sandstone. In the N. part of the district this stratum is remarkable for the quantity of mica that it contains, which causes the sandstone layers to split into large slabs with a glittering micaceous surface, and imparts to them at the same time a crumbling texture. In other situations it abounds in vegetable impressions, apparently the stems of arundinaceous plants, &c. Very frequently, particularly in the lower part, it is a very soft brown and black shale, readily disintegrating, and has a splintery fracture, breaking off in long thin prismatic fragments like the splinters of decaying wood. The surface is often covered with an efflorescence, a part of which is copperas. There are two varieties of this encrusting matter—one is a salt of a pure white colour in delicate crystals, and a greenish-yellow mass, into which the former passes by longer exposure to the atmosphere. The whole stratum varies much

in its dimensions, being in some places very thick, and in others only from 5 to 10 feet. It may, however, be estimated at 30 feet of average thickness. It does not contain the Redstone Coal-bed.

Above this occurs the Pittsburg Sandstone about 25 feet thick, and the shales 20 feet, upon which lies the Great Limestone.

The Great Limestone.—This bed may be traced from the vicinity of Pittsburg continuously up the Monongahela to the Virginia State line. It is a non-fossiliferous deposit, no fossils having been hitherto found imbedded in it, notwithstanding the frequency with which it has been examined in tracing its range through the country. The variation in the thickness, and particularly in the composition of the stratum, is remarkable. It consists of numerous beds of limestone separated by thin seams of shale. These beds are sometimes in contact, at others they include thin layers of shale from 1 to 8 feet in thickness. Instead, however, of these partings of shale, we occasionally meet with dividing-bands, consisting of a sandstone which is calcareous, effervescing slightly with acids, and passing sometimes insensibly into the limestone.—The limestone itself is generally of a blue colour of various shades, is excessively hard, and breaks with a semi-conchoidal fracture. At other times the layers are black or light yellow, and contain transparent specks of crystallised carbonate of lime. The latter variety is frequently very beautiful, and apparently hard enough and fine enough in texture to receive a good polish: it would make a handsome ornamental marble, although the thinness of the layers would interfere with its extensive use for architectural purposes. The black kind is very hard, of a slaty structure, and gives out a fœtid or bituminous odour when bruised or struck. This kind is generally found in contact with the interposed black shale. In some instances it passes insensibly into it, when the shale becomes a black calcareous slate, splitting readily into smooth plates, and effervescing freely when touched with an acid. Most generally the shale is very soft, of a deep blue or yellow colour, imperfectly laminated, and decomposing readily into a soft clay. Not unfrequently it contains layers of calcareous nodules. Occasionally it is very soft and black, resembling the outcrop of a coal-seam. In the S. part of the district, instead of shale we find two thin layers of *coal* separating the limestone-beds. The largest of these is 2½ feet thick, and has been opened in several places as a *coal*-seam.

This well-characterised member of the series is readily recognised, and is very generally exposed in the ravines and hill-sides; but being a rather variable mass as regards its minuter features, it is by no means easy to ascertain in every case its precise composition. The quarries established in it are generally mere uncoverings of the upper layers. Such is the case with those in Wilkins and Monongahela townships, Alleghany County, where the rock seems to thin off towards its N. outcrop.

In Alleghany and the N. part of Westmoreland counties it is met with, covering the highest hills with its lower layers. These are sometimes seen capping the insulated summits of the hills, and forming a natural pavement, completely detached from the surrounding strata. Advancing towards the S., we find it gradually sinking under the hill-tops, and showing itself lower down on the sides of the creeks and small streams, and becoming at the same time thicker.

There are but few of the streams, or even small runs, emptying into the Monongahela from Elizabethtown to the Virginia line, along which this stratum is not well exposed, its beds either forming a series of horizontal steps or platforms in the smaller watercourses, or steep and smooth escarpments on the hill-sides. On its almost incalculable value to the agriculture of our S.W. counties, I need not dwell; but I cannot refrain from expressing a sincere regret that the importance of lime as a fertiliser should continue to be so much overlooked. It is proper in this place to observe, that the shales between the limestone-beds themselves are frequently very calcareous, and are consequently, in many cases, genuine *marls*, both as respects their composition and their agency upon the soil.

CHAPTER XXVIII.

THIRD SUBDIVISION OF THE THIRD GREAT BASIN SOUTH OF THE GREENSBURG AND PITTSBURG TURNPIKE.

THE Pittsburg Seam, in the Third Subdivision of the Third Basin, is cut on its E. outcrop on the Pennsylvania Railroad, about 1 mile W. of Grapeville Station, and is opened upon the Greensburg and Pittsburg Turnpike, half a mile E. of Adamsburg, with a gentle W. dip. In the neighbourhood of Irwin's it is extensively mined by the Westmoreland Coal Company. At this point it dips very gently Eastward.

Tracing the outcrop S. from the turnpike, we find it opened on the lands of Mr Bess and others: coal, 7 feet thick. It is opened at numerous places farther S. and at Taylor's mill, all within 4 miles of the turnpike. The latter is half a mile E. of Madison.

Between this and the Sewickly Creek the bed has been opened sometimes on the E., sometimes on the W. side of the hills that contain its last E. outcrop in this subdivision. Upon the hills of the creek, and 80 feet above the water, it is mined at Kiefer's old bank, where a bed of limestone is seen 15 feet below the coal.

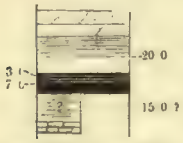


FIG. 516.—Sewickly, (Markle's Paper-Mill.)

This range of openings is W. of the termination of the second sub-axis. From the country E. of them the bed has been swept away, its outcrop sweeping S. from the point where it crosses the Sewickly at Kiefer's, and then S.E. to range along the side of the first sub-axis.—(See the Map.)

Eight feet above the water, upon the S. bank of the Sewickly, the Pittsburg Coal-bed has been opened at Markle's paper-mill.—(See Fig. 516.)

As the outcrop ascends the hills in a S. course towards the Mount Pleasant Turnpike, it is opened within half a mile from the turnpike, and exhibits a thick coal-seam, and limestone below it 6 feet in thickness. (See Fig. 517.) It is again opened on the turnpike road, 9 miles from Mount Pleasant, and frequently between this point and the Youghiogheny along its E. outcrop.

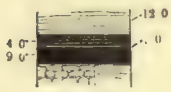


FIG. 517.

S.W. of the same point, between it and the river, in a space of 2½ miles, it is also opened in several places. Most of the openings are in the draught running down S. to Smith's mill, on the Youghiogheny. Within three-fourths of a mile from the river are Frick's, Shoop's, W. & S. Rhode's openings; and on the N.E. shore of the river, about 1 mile below the mouth of Jacob's Creek, is Porter's bank. Near this the bed crops out on the top of the hills. Anderson's bank, 300 yards from Porter's, is not high above water-level, and a short distance below this the bed ascends beneath the bed of the Youghiogheny.

FIG. 518.

Returning to the Pittsburg Turnpike, and descending the Youghiogheny River, we find the Pittsburg Coal-bed opened at the top of the hill, 17 miles from the latter city, and measuring as in Fig. 518:—

Roof, Shale. *Coal*, 4 feet; Clay, 1 foot; *Coal*, 4½ feet.

Ten and three-fourth miles from Pittsburg, the Pittsburg Sandstone has been quarried; it is a yellowish-grey coarse sandstone, slightly micaceous.

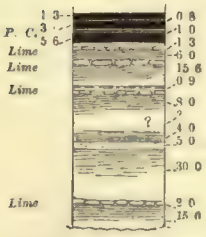


FIG. 519.—Turtle Creek.

Half a mile E. of the latter, and perhaps 30 feet below the hill-tops, is a coal-bank (Pittsburg Coal), which gives the following section:—

Shales and Sandstone, 10 feet; *Coal* and Shale, 15 inches; Clay, 8 inches; *Coal*, with thin slate, 3 feet; Clay, 1 foot; *Coal*, 5½ feet. Interval, 2 or 3 feet; Limestone, blackish, 15 inches; Slate and sandstone, 6 feet exposed.

Continued downwards, the section shows further some thin limestones. That marked 9 inches in the section is peculiar, of a dark-green colour, granular and speckled, resembling some of the bands of the Umbral Limestone on Chestnut Ridge; then come purple shales, as at Pittsburg, until we reach the fertile wide flat of Turtle Creek.

Descending Turtle Creek 1½ miles to Funk's mill, a white cliff of sandstone is seen overhanging it, and this is the last-mentioned sandstone of the above section ; it is light-grey, homogeneous, micaceous, with dark, smooth, ferruginous nodules, and at a height of 50 feet above the water ; under it are shales, 30 feet thick. Beneath these last is a bed of Fossiliferous Limestone, 2 feet thick, dark-grey and slaty. This again lies upon soft yellow shale in the creek.

The purple shales are very persistent along the creek. The Fossiliferous Limestone crops out from the bank of the creek half a mile above the bridge, 2 feet thick, of a greenish-grey colour, and full of fossils. The red shales above it effervesce with acid, and contain minute fossils and concretions. This is 25 feet above the water of the chief branch of Turtle Creek. In the hill over it a heavy sandstone stratum crops out.

McCulloch's bank is 13½ miles from Pittsburg. The upper member of the coal, 3 feet thick ; the lower member, 6 feet. Shales and slates continue for 40 feet to the summit of the hill.

On the hill-tops bordering the Monongahela River on the S., and the Pennsylvania Railroad on the N., there are numerous openings upon the Pittsburg Seam, from which large amounts of coal are extracted. The coal is lowered from the mines upon inclined planes, and loaded upon boats on the river.

At the road to McKeesport the Pittsburg Coal is opened on the S. bank of Turtle Creek, 1½ miles from the river, and at the same elevation as upon the river opposite that town. It is probable that the Fossiliferous Limestone, which we have above described, will be found in all the deep runs which descend to the river in the neighbourhood.

FROM McKEESPORT TO ROBBSTOWN (WEST NEWTON) ALONG THE YOUGHIOGHENY RIVER.

At the mouth of the river an alluvial flat occurs upon the N. side, from which the hill-sides rise steeply, exhibiting a line of low cliffs formed by the sandstone stratum above the Fossiliferous Limestone. A mile farther up, where it is 50 feet above the present water-level, it shows unequivocal marks of the action of flowing water.

Two miles from the mouth, the bottom is half a mile in width, and the hills are low, and frequently cut down by side-ravines. Here is Craven's salt-well, 460 feet deep, which emitted large quantities of carburetted hydrogen gas.

No written account was kept of the borings, but the following details are remembered :—

Coal, 12 feet (?) thick, the Elk-Lick bed, bored through at a depth of 75 feet. This intimates the presence of a bed, with top and bottom slates ; again *Coal*, 2½ feet thick, at a depth of 400 feet.

In a creek, which enters the river half a mile above this, is seen a thin band of a fossiliferous limestone, and over it 3 inches of carbonate of iron in nodules.

Around Graham's mills, and 100 feet above the present water-level, lie great water-worn blocks of sandstone upon the hill-sides.

Where the road crosses the hills to descend again to the river, the country exhibits exposures of the Pittsburg Coal, with the coal and limestone strata above it. The Uniontown (or Sewickly) Coal just enters the tops of the hills. An exposure of the Pittsburg Coal is seen descending the ravine to the river : *Coal*, 1 foot ; clay, 9 inches ; *Coal*, 3 feet ; clay, 8 inches ; *Coal*, best, 6 (8 ?) feet exposed (see Fig. 520). Dark-blue limestone in the bed of the run. It shows a slight dip N. 45° E. Six other drifts are opened on the run, which the limestone, 7½ feet thick, underlies for 300 yards.

At *Snyder's mill*, upon the N. side of the river, are two drifts upon the Pittsburg Coal, at a height of 80 feet above the water. Brown shale extends above it. A short distance below it is the usual thick limestone stratum, here 3 feet thick, remarkably hard and solid, and covering the shore with the fragments of its outcrop. Under it are at least 15 feet of shale. This is 6 miles below Robbstown.

The coal at this point is subdivided into—*Coal*, good, 4 feet ; clay, 1 foot ; coal, 6 feet exposed. (See Fig. 521).

High above two banks, a quarter of a mile farther up the river, heavy strata of sandstone crop out along the hill ; the coal itself is here 70 feet above the water.

A mile farther up, the massive limestone, now 4 feet thick, skirts the water-level, and finally disappears beneath it.

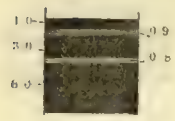


Fig. 520.

At the mouth of Little Sewickly Creek, the Great Limestone (above the Pittsburg Coal) forms with its thick strata the hill-side, while the coal-bed lies in the creek.

Fig. 521.

On the N. bank of the Big Sewickly the Great Limestone is seen in walls 30 feet high, a stratum of slaty sandstone seemingly dividing it midway at about 50 feet above the creek. The Pittsburg Seam is probably above water-level at the mouth of the Big Sewickly Creek.

The limestone is again well exposed half a mile farther towards Robbstown, where a rivulet enters the creek. It presents appearances precisely analogous to those that characterise it at Brownsville. A section of it (see Fig. 522), commencing at about half the height of the hill, and descending in the series of its strata, will read as follows:—

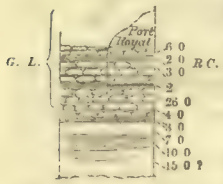


Fig. 522.—Sewickly Creek.

Limestone, hard and blue, 6 feet. Shale, blue, 2 feet. Limestone, black, slaty, but with a clean fracture, and effervescing freely, 3 feet. Limestone, light-blue, weathering white, in layers of 2 feet each, two of them of a flaggy structure, 26 feet. Limestone, dark blue, in layers, 4 feet. Clay, or calcareous blue shale, 3 feet. Sandstone, grey, slaty, micaceous, 7 feet. Shale, yellow, brown, and black, 16 feet exposed, but it probably continues down to the water of the creek, and is then 25 feet thick.

At Robbstown (West Newton) the Pittsburg Coal-bed has already sunk below the river-bed of the Youghiogheny.*

From Robbstown to Port-Royal, 4 miles above the former place, the outcrops of the Great Limestone scarp the sides of the valley, forming the major part of the hill-sides, and contain at Port-Royal the *Redstone Coal-bed*, 2 feet thick, of good quality, and lying immediately between two layers of the limestone mass.—(See Fig. 522.)

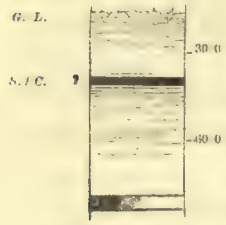


Fig. 523.—West of Robbstown.

At Pollock's mill, 1 mile W. of Robbstown, the *Sewickly* (?) *Coal* occurs, 60 feet above the Pittsburg Bed, 3 feet thick. No limestone is seen between them. The quality of the latter is good, but its thickness is very variable, it thins out locally in some directions.—(See Fig. 523.)

The next coal above is seen 4 feet thick, in a high knoll 2¼ miles W. of Robbstown, and near the turnpike. Near the roof is a clay-bed 6 inches thick. It is a brown inferior coal, with 30 feet of hill above it.

The same seam (Uniontown?) is opened at nearly three-fourths of a mile S.W. of the last locality; and here the Great Limestone is exposed plainly below it.

The Pittsburg Coal is exposed at the mouth of the run which enters the Monongahela, S.W. of the last-named opening, and 2 miles above Williamsport.

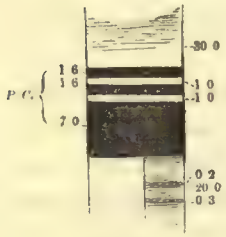


Fig. 524.

For 6 miles above Robbstown the massive fragments of the Great Limestone cover the shores of the Youghiogheny.

The Pittsburg Coal-bed at Port-Royal must be at a considerable depth below the river-bed, since the shales above it form the banks, and the coal emerges at a mill one and a half miles above the town. At an imperfect opening, half a mile above the mill, a clay stratum, 2 inches thick, may be seen traversing a section of the coal 2 feet in thickness, in a diagonal direction. At another opening, half a mile higher up the river, the members of the bed are as follows—(see Fig. 524.):—

Shale, 30 feet; *Coal*, 18 inches; Clay, 1 foot; *Coal*, good quality, 18 inches; Clay, 1 foot; *Coal*, 7 feet exposed.

The bed rises with sufficient rapidity to be 35 or 40 feet above the water, at the two next openings a fourth of a mile higher up the river. Under the coal, shale appears for 20 feet, containing ten small bands of ore; the lower one is nodular.

Half a mile below the mouth of Jacob's Creek, and upon a run which enters the river by the left bank, are

* The first coal-bed struck in boring the salt-well here was at a depth of 280 feet.

openings upon the Pittsburg Coal-bed, exhibiting the two clay interlayers and the lower member, 8 feet thick. Fifteen feet beneath the coal, the limestone appears in the run very black, hard, and in a single massive stratum; beneath it is a grey calcareous sandstone. The coal-bed is again opened at Whitaker's mill.

Mr Davis's Bank is the first upon the S. side of the river, a little below the mouth of Jacob's Creek, and 25 feet above the water-level.

Above the mouth of Jacob's Creek, on the N.E. side of the river, a small isolated patch of the Pittsburg Coal-seam has been left opposite the shovel-factory.

As the seam rises, when traced up the Youghiogheny River, it has been opened 1 mile above the mouth of Jacob's Creek, and 70 feet above the stream: the roof is slate and sandstone. It appears again in the first ravine from the S.W. above this bank: here the coal strikes the water-level of the stream in the ravine, and disappears at the river, 350 yards from it.

The Pittsburg Coal has been repeatedly opened along the river-shore, still farther up, as it gradually descends to the water-level, being mined only 15 feet above the stream at the shovel-factory, 2 miles below Perryopolis.

Here the bed begins to rise as we continue to ascend the river, and is opened at an elevation of 70 or 80 feet, 500 yards above the factory: the outcrop then turns into a little valley which enters from the S.E, and ascends its left bank.

The hills from hence to Perryopolis are not high enough to contain the bed: they rise abruptly from the river, but do not attain an elevation of more than 150 feet, their summits forming the edge of the so-called flats of Washington. A level of 1000 acres is covered with round water-worn stones, and surrounded by a lofty and denuded country.

The surrounding hills are rounded and low. In this neighbourhood a pure sand is obtained, which is used for making glass both here and at Pittsburg.

Carson's sandbank is about half a mile from the river, on the edge of a sloping hill, and is about 20 feet deep. The general colour of the sand is pale reddish-yellow. Where the sand is pure white, the grains are seen to be soft, fine, and much smaller and cleaner than the yellow grains. The side of the hill is covered with rounded blocks of sandstone, from 12 to 20 inches in diameter. Perfectly-rounded pebbles of sandstone, as large as a man's fist, are imbedded in the sand itself for several feet below the surface. The sandstone of these boulders bears the aspect of the peculiar "salt-rock" of the Chestnut Ridge. Blocks of coarse conglomerate, with white quartz pebbles, are mingled with them, and come from the direction of Laurel Hill or Alleghany Mountain still farther E.

A section of the layers in the sand quarry is as follows:—

Soil, with sand and pebbles, about 3 feet. Sand, brown, impure, 4 feet. Sand, very white, in regular layers, 9 inches. Sand, brownish-red with black streaks, and quite compact, 4 feet.

It is supposed that the sand results from the decomposition of the extremely friable, loose, "salt-rock" boulders, and the stratification of their disintegrated constituents has occurred in hollows of the surface along the benches of the hill-sides.

Other localities occur between Perryopolis and East Liberty, where the relation between the sand and boulders may be satisfactorily studied. Four miles above Perryopolis, blocks of the salt-rocks are seen upon the surface, 10 feet square by 4 feet thick, lying irregularly in the woods, and sometimes partially decomposed; they are externally of a dark-grey colour, but internally of a yellowish-brown, with red streaks, very friable, coarse-grained, and readily fractured. The edges of the harder parts of a block resisting decomposition are traceable in numerous nearly parallel ridges across its surface. These ridges are of a dark-red colour, and contain more iron than the rest of the mass. The irruption of these blocks certainly dates with the breaches of the Youghiogheny gaps through Chestnut Ridge and Laurel Hill.

Perryopolis.—The coal-openings S.W. of the town are Fuller's and Campbell's, one a mile and a quarter from Perryopolis, and one at G. Stickler's, at the steam-mill, near the water-level, and dipping pretty steeply W.: one mile S. of the last, Mr Power has an opening high upon the hills which border the valley in which is Stickler's

mill. Besides these we may notice as opened at the time of our visit, A. Robison's, R. Patterson's, near its W. disappearance below the water-level of the run; half a mile farther S., Cook's and Wolf's (floor here limestone), Hazen's; E. Cope's, at the bottom of a deep draught S. of Hazen's; Fraser's, half a mile from the Redstone, where the hills are high rounded knobs, overtopping the hills upon the first sub-axis, W. of them; McVey's and Sharpless's, where the outcrop falls into the Redstone valley, low down and near the hill, 3 miles below the Connellsville Turnpike. Here the lower coal-bench is 9 feet thick, 1 foot blue shale; upper member, coal and slate, 4 feet; roof, blue slate, 12 feet.

Tracing the outcrop of the Pittsburg Coal-bed in the second subdivision of the third great basin S. from the point where it crosses the Redstone Creek, it dips E. underneath the water, 300 yards below Sharpless's mill: it has been opened by Mr Hornbeck a quarter of a mile above the mill, and by Brown, McCoy, Cowell, Vale, and Seanight, near the National Road. E. of Vale's, and high on the hills, are Mr Wood's openings; Graham's, and others, near the National Turnpike, as well as at the turnpike E. of the toll-gate, 5 miles from Uniontown.

ROCKS ABOVE THE PITTSBURG COAL, WEST OF THE SECOND SUB-AXIS, AND SOUTH OF THE PITTSBURG AND GREENSBURG TURNPIKE.

The rocks of the upper series, forming the hills along the Big Sewickly Creek, between the two outcrops of the Pittsburg Coal-bed, at the termination of the second sub-axis, are given as accurately as the observations could admit in the section (Fig. 525) as follows:—

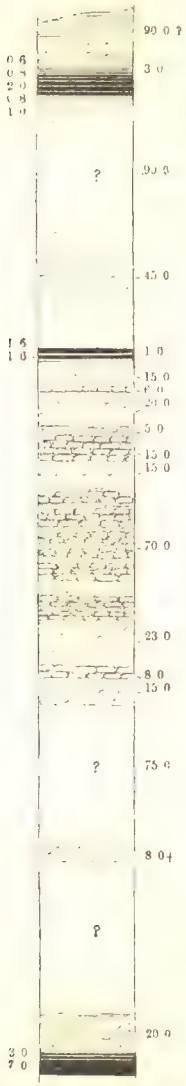


Fig. 525. Big Sewickly Creek.

Slates and Sandstones in the highest hills, 90 (?) feet. Coal-bed constituted thus: Black Slate, roof, 3 feet; *Coal*, 6 inches; Blue Shale, 6 inches; *Coal*, 8 inches; Blue Shale, 3 inches; *Coal*, with thin slaty interlaminæ at every inch, 2 feet; Blue Slate, 8 inches. *Coal*, 8 inches; Blue Slate and Coal, 1 foot. Strata not exposed, 90 feet. Coarse grey Sandstone, lower part greatly contorted and filled with wedges of coal, 45 feet. *Coal*, 18 inches; Slate, with interlaminæ of coal, 12 inches; *Coal*, 18 inches; Thin Slate. Grey Sandstone, 15 feet; *Limestone*, 6 feet. Micaceous Sandstone, flaggy, 20 feet; Blue Slate, 5 feet. *Limestone*, massive, 15 feet. Coarse grey Sandstone, massive, 15 (?) feet. Limestone, blue, yellowish, whitish, pure or silicious, including thin layers of sandstone and slate; and 10 feet of dark olive shale, few fossils in any part of the mass, 70 feet. Micaceous sandstone, 23 feet; *Limestone*, 8 feet. Micaceous Sandstone and olive slate, 15 feet. No exposures, 75 feet; Sandstone, 8 feet, exposed. No exposures, 85 feet; Dark olive Slate, 20 feet. Pittsburg Coal, upper member, 3 feet; lower, 7 feet.

The Sewickly and Redstone coal-beds do not appear in this section; they probably occur in the lower intervals.

The Great Limestone in the section crops out along the hill-sides from the Presbyterian Church, where it was observed all along the creek as far as Markle's mill, forming steep banks of considerable height, and lying nearly horizontal, only one or two undulations being perceptible.

The whole thickness of the rocks in the upper part of the section obtained above the mill is probably under-estimated, as several exposures could not be so identified as to appear in the section.

The double coal-seam is probably the Uniontown Coal.

The 9-feet bed of mixed coal and slate is found high on the hills S. of Markle's mill, and reminds us of Cox's Coal, occupying a similar stratigraphical position on the highest knob in the first sub-basin S. of the Youghiogheny River. This is the bed, the outcrop of which is seen upon the Robbstown and Mount Pleasant Turnpike.

The Sewickly Coal-bed rises from the water 3 miles below Markle's mill, and the Pittsburg Coal re-emerges 1 mile farther on, the first opening upon it being 1 mile from the mouth of the creek.

Following the upper group of rocks above the Pittsburg Coal-bed, Southward to the

valley of the Youghiogheny, below the mouth of Jacob's Creek we see exposures of them, which we have placed in sectional form (Fig. 526).

The Pittsburg Seam, opened by Messrs Anderson and Porter, rests upon blue slate 10 feet thick, and this on sandstone. It is overlaid by 40 feet of brown shale, and disappears beneath the water. Five hundred and fifty yards below its disappearance, the Sewickly Coal-bed is seen in an opening. This bed is here 4 feet thick; it yields good coal, and is overlaid by soft brown shale, with sandy layers and blue shale, splintering like old wood when fractured; over this lies sandstone, and over it the Great Limestone strata.

Fig. 526.—Youghiogheny River.

Calculating the vertical distance between the two beds from the distance between the openings, and supposing the uniform dip of the rocks 5°, it will be about 115 feet.

One-fourth of a mile below this opening, and opposite Smith's mill, in the hill-side S. of the river, we find material for continuing the section upwards, thus:—

Blue Shale at the water-level. *Coal*, deep-black, hard, shining, at the water-level, 3½ feet; Roof, black Slate, 3 feet; Slate, 12 feet, blue, including a limestone stratum, 3 feet thick; Sandstone, 10 feet; Yellow and olive Shale, 25 feet; *Coal*, 2 feet; Limestone roof, impure, yellowish, massive, 12 feet.

At Williamsport (Monongahela City) several drifts are opened upon the Pittsburg Coal, exhibiting in all the same relationship existing between its members, viz.:—

Soft yellow Shale, 6 feet; *Coal*, impure, 3 feet; Clay, 1 foot; *Coal* (lower member), 6 feet; Limestone, top visible.—(See Fig. 527.)

Ten feet under the coal is seen the top of a brown shale stratum, 20 feet thick, full of ferruginous concretions. Pursuing the course of the Pigeon Creek upwards from the town of Williamsport, a stratum of sandstone, 10 feet thick, is observed in many places capping the hills on each side: it is separated from the Pittsburg Coal by the capping of shales which overlie the latter, and it may be considered the representative of the Pittsburg Sandstone.

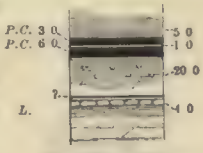


Fig. 527.—Williamsport.

At the mill-dam, 1¼ miles above the town, the limestone under the Pittsburg Coal forms a broad checkered pavement for the creek, and a little above this the coal itself forms the bed of the stream. Above this, shales and sandstones occupy 30 feet.

At Williamsport, the hills to the W. form a flat table-land, covered by the Pittsburg Sandstone; those to the E. are greatly more elevated, rising 300 feet steeply from the river; but they afford no natural sections. At their base runs the outcrop of the Pittsburg Coal and underlying limestone.

A quarry of sandstone, covered with shale, occurs above the roadside; and two-thirds of the distance up the hill, 30 feet thickness of it is exposed.

Two miles from Williamsport, on the Brownsville State Road, the Great Limestone appears in the stream, from 30 to 35 feet thick, and in 6 or 8 layers, overlaid by slaty grey sandstone, upon which are several additional layers of limestone. Where the State Road crosses the Turnpike Run, above Greenfield, the Pittsburg Coal is opened; it is thus subdivided:—

Lower member, *Coal*, 7 feet; Clay, 1 foot; Upper member, *Coal*, 1 foot; Black Slate, 3 feet.

From this bed, which is here 30 feet above the water, great quantities of coal have been extracted farther up the run. Between Morris's banks and Fredericktown the Pittsburg Coal-bed has the Pittsburg Sandstone immediately resting upon it; a fact which we may ascribe to an ancient slide hiding the outcrop of the intermediate shales, which may be explained by an imaginary section, as in Fig. 528. (*A b* represents the soil on the face of the hill, *c* the shale, the outcrop of which is covered by the slide of the sandstone above.) The hills are very steep, and remains of such slides are visible. At Fredericktown the Pittsburg Coal is at least 50 feet above the river.

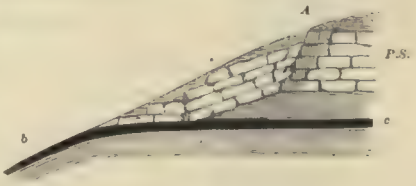


Fig. 528.

Between the quarries below Belvernon and Columbia, the Pittsburg Coal lies high upon the hill-sides, over-

looking the Monongahela Valley. At two drifts, 2 miles below Columbia, the bed is opened 140 feet above the water-level. Beneath the coal a sandstone stratum, 10 feet thick, is seen. A limestone stratum is seen above the coal, and another below it, at an opening up a run which enters the river at this point.

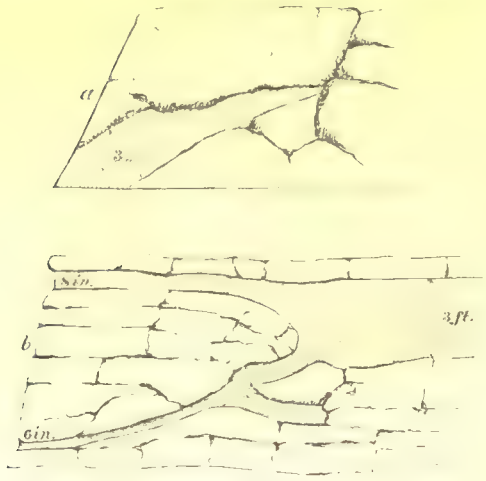


Fig. 529.

Half a mile below Cookstown, the Pittsburg Coal is opened at an elevation of from 100 to 120 feet.

Half a mile below Belvernon, on the W. side of the river, is the sandstone quarry (Pittsburg Sandstone ?) which furnished the stone for the Williamsport Bridge. It is a hard, compact, tough material. Some layers of it contain ferruginous concretions, which injure its appearance, and increase the difficulty of working it as a building-stone. The colour is light-yellow and grey. The main breast is a stratum 18 feet in thickness, containing carbonaceous impressions on the surface.

Upon the sandstone is a mass of compact slates, 20 feet thick, seemingly once subjected to great pressure from above, and filling the chasms and interstices of the sandstone mass beneath it; the line of juncture between these two formations is extremely irregular. In one instance observed, the inserted rock was a mixture of ferruginous clay, slate, and impure coal. The same appearances are observed in the quarries at Williamsport.—(See woodcuts *a* and *b*, Fig. 529.)

Fig. 530.—Pike Run.

At the town of Greenfield, and below it, are numerous drifts in the Pittsburg Coal, the variable types of which will be comparable from the accompanying vertical sections. At the first drift (Fig. 531) the coal is about 25 feet above the run; at the second (Fig. 530), the limestone underneath it is 10 feet thick, and divided by layers of soft black shale. Here some layers of iron ore, 3 inches thick, occur in the bed of the run. The limestone is water-worn, and reddish on the surface, yields readily to the knife, and is full of vegetable remains, as are also the slaty layers.

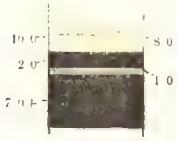


Fig. 531.—Below Greenfield.

The fourth drift is at the steam-mill.

At the second drift upon the river below the town, a sandstone 18 inches thick rests immediately upon the upper members. The bed is about 50 feet above the water.

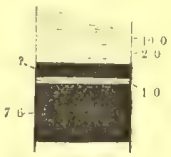


Fig. 532.—Below Greenfield.

Two miles below Brownsville, a coal-bed is seen on the Greenfield Road, on the top of a high hill. Assuming Brownsville as a centre of observation for the surrounding country, where investigations are not readily reduced to accuracy through continuous vertical sections, we offer the following as a *typical section*, based upon examinations first made here, but afterward extended up and down the river and its numerous side-waters. The section is exhibited in Fig. 533:—

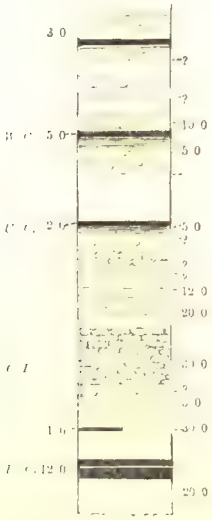


Fig. 533.—Brownsville.

Yellow Shale. *Coal*, 3 feet. Yellow Shale, coarse brown sandstone. Shale, blue, yellow, sometimes wanting, 10 feet. *Coal*, 5 feet (Waynesburg Coal). Yellow Shale (upper part clay) with concretions, 5 feet; Black and yellow Shale, 40 (?) feet. *Coal*, 2½ feet (Uniontown ? Coal). Soft yellow Shale, 5 feet; black and yellow Shale, with sandstone layers. *Limestone*, upper layers black and slaty, separated by shale. Slate generally brown, friable, and fossiliferous; paving sandstone, fine-grained, excellent building-material, micaceous on the surface, compact or slaty, lower part generally compact, abounding in vegetable impressions, 12 feet; Yellow and black Shale, 20 feet. Limestone, hard surface, white, blue within, interlaid by Shales, blocks crumbling on exposure, sometimes scaling off with conchoidal fracture; upper portion blackish and more slaty, exhibited on National Road, at Kreb's Hill, Mouth of Redstone, Muddy Creek, &c., forming high white precipitous cliffs, 30 feet. (*Great Limestone.*) Shale, brown

and yellow, thin; Sandstone (Pittsburg Sandstone), compact, here only 5 feet; Shale (sometimes absent), brown, with layers of sandstone (increasing in number upwards), contains on Redstone a thin coal-bed (Redstone Coal), 30 feet. *Pittsburg Coal*, two members, and clay between, 12 feet thick.

Opposite Brownsville, a high sharp hill called Kreb's Knob, overlooking the surrounding country, and visible from a great distance, exhibits the following section—(see Fig. 534):—

No exposures except a few thin layers of Limestone, and a thin coal outcrop, 50 feet. These are near the summit, but above them are visible at one place 20 feet of Sandstone, and a coal-bed evidently thin. No exposures, but fragments of Limestone, 35 feet. Micaceous Sandstone, with coal laminæ at its bottom, 40 feet; Blue Shale, 2 feet. *Coal*, 1 foot; Blue Slate, 4 to 8 inches. *Coal*, 15 inches. No exposures, 65 feet. Micaceous Sandstone, 7 feet; No exposures, but fragments of Lime and Sandstone, 23 feet; Blue Shale and sandstone, 10 feet. Great Limestone of different colours, alternating with blue shale, 30 feet; Dark olive Slate and sandstone layers, 28 feet. Limestone, yellow, impure, at water-level, below which but a small distance must lie the Pittsburg Coal-bed.

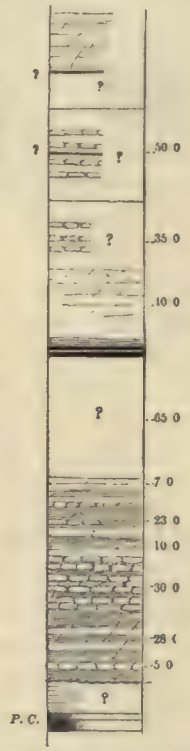


FIG. 534.—Kreb's Knob, at Brownsville.

On the road to the E. of Brownsville, the following section (Fig. 535) was compiled:—

Brown and black Slate from 8 to 20 feet; the Great *Limestone?* fine-grained, with layers of light-blue shale, disintegrating upon exposures, from 25 to 40 feet; Yellow Shale.

Above these occurs a limestone bed, 4 feet exposed; and near the summits of the hills, 150 feet higher, the following descending series of rocks:—

Coarse brown Sandstone, 25 feet; Blue and yellow Shale, 5 feet; *Coal*, 5 feet; Shale, 5 feet, &c.

This is a valuable bed of coal. The sandstone is exposed in three separate quarries along the turnpike, and forms the summits of the hills. It is coarsely compacted of water-worn grains of quartz of the size of small shot. Its larger layers have their grains united by no cement, and therefore exposure rapidly crumbles it down into a coarse sharp-grained white sand. The strata are much disturbed and broken, though maintaining their general horizontality. Upon the run, below the Great Limestone, the following rocks were discovered:—

Sandstone, 20 (?) feet; *Black Limestone*, with interposed Shales, 20 (?) feet; Sandstone, 20 (?) feet; Yellow and black Slate, 8 feet; *Coal*, 1 foot; Black Slate, 35 (?) feet; *Pittsburg Coal.*

Here the Pittsburg Coal shows two members thus:—

Black laminated Slate, 17 feet; highly carbonaceous pyritous Slate (upper member), 2 feet; Clay, 1 foot; *Coal* (lower member), 7 feet.

This slaty upper member will burn when mixed with the lower coal, and moistened. The nodules of sulphuret of iron, when broken, exhibit vegetable impressions. The limestone beneath the Pittsburg Coal is separated by horizontal planes of clay and black slate; it is sometimes slaty, sometimes compact, and emits a strong bituminous odour when freshly broken. It is 10 feet thick at one drift; at another drift it has beneath it—

Black laminated Shale, 2 feet; *Coal*, 1 foot; Limestone, 15 inches; Soft blue Shale, full of calcareous nodules, 6 feet in the bed of the run.

The Great Limestone is again exposed a mile higher up the run. In one quarry, on the brow of the hill, behind the Cove, the Pittsburg Sandstone is seen to contain abundance of Calamites and vegetable impressions in the solid layers.

The Pittsburg Seam is opened at Cox's and Mitchell's banks. At the mouth of the former drift the clay band is not visible; in the other, it is 2 feet thick.—(See Figs. 536, 537.)

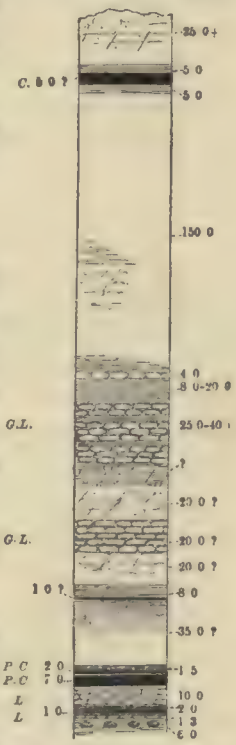


FIG. 535. — East of Brownsville.

In Fig. 538 we have a section of the rocks above the Pittsburg Coal, as exposed along Redstone Creek between Sharpless's mill and its point of emergence near Linn's mill, thus—

Fig. 536.—Cox's Drift.

Fig. 537.—Mitchell's Drift.

Slate and Sandstone, thickness unknown; Coarse grey Sandstone, massive, 40 feet. *Coal*, with Slate seam, from 6 to 8 inches thick, $1\frac{1}{2}$ feet; from the roof, 4 to $4\frac{1}{2}$ feet. A few exposures of slate, &c., 20 feet. Limestone, yellow and blue, impure, with slate bands, 10 feet. No exposures, 37 feet; Micaceous Sandstone, blue and grey, 18 feet; Yellowish and bluish Shale, 4 feet. *Coal*, soft brown, crumbling, from 3 to 4 feet; Floor, black Shale, 2 feet; Limestone, blue and ash-coloured, 12 feet; Calcareous yellow Shale, 4 feet; Yellow Shale, with grey Sandstone, 16 feet. Not exposed, 9 feet; Slate, with calcareous layers, 17 feet. Great Limestone, strata of different colours, and interlaid with slates and shales, 67 feet. Dark olive and brownish Shales, and slates with layers stained with the rust, and containing occasional nodules of carbonate of iron. Pittsburg Coal, 8 feet.

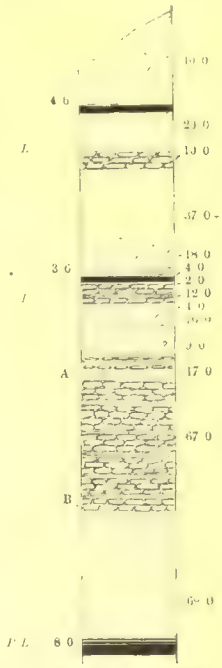


Fig. 538.—Redstone Creek.

From A upward the rocks were measured in a gorge near Redstone paper-mill, about $3\frac{1}{2}$ miles from the mouth of the creek, and from B downwards, near Linn's mill. Though the parts were measured, some error may exist in the manner of their connection in the section. The section at Brownsville, however, confirms the general view as correct.

The Great Limestone is often exposed along the creek.

Upon the road leading Northward from the National Road, $5\frac{1}{2}$ miles E. of Brownsville, lie great masses of a ponderous sandstone stratum scattered over the surface.

About 3 miles from the turnpike, the Pittsburg Coal-bed is wrought at the bottom of a run, it is roofed with black slate, and sandstone is exposed for 15 feet above.

Beneath the coal is seen a limestone bed in several layers, 10 feet thick; one of the layers contains nodules of iron ore. Blue slate underlies the limestone, and passes downwards into sandstone, which occupies the run thence to the Redstone Creek. The lower part of the shale is full of calcareous concretions, from 1 to 12 inches in diameter.

The Pittsburg Coal at this locality is about 40 feet above the level of the creek, and rises Westward obedient to the first sub-axis.

Higher up the run the *Great Limestone* is seen.

UPON THE ROAD FROM BROWNSVILLE TO UNIONTOWN.

The *Five-Feet Coal* (Waynesburg [?] Coal) can be traced along the National Road a distance of 4 miles from Brownsville eastward to its Eastern outcrop.

The *Two-and-a-Half Feet Coal* (Uniontown [?] Coal) crops out upon the National Road $5\frac{1}{2}$ miles E. of Brownsville; and the Pittsburg Coal-seam, $7\frac{1}{2}$ miles E. of Brownsville, and $4\frac{1}{4}$ from Uniontown. Its Eastern outcrop has already been traced by the line of openings upon it. Here the coal dips at an angle of 2° W. The Westerly dip continues evident to within 2 miles of Brownsville.

Upon the road leading S. from the first milestone E. of Brownsville, the sandstone above the Waynesburg (?) Coal-bed appears in large blocks strewed about; it is of a coarse and friable texture. Farther S. is seen the outcrop of a higher coal, at least 3 feet thick. The Five-Feet (Waynesburg [?] Coal) appears on the hill-side 60 feet below it; roof, yellow shale (covered by gravel and pebbles of sandstone, and then the soil), 3 feet; *Coal*, $2\frac{1}{2}$ feet; Clay, 7 inches; *Coal*, good, $6\frac{1}{2}$ feet exposed—perhaps thicker.

The sandstone above mentioned, in very large blocks, is again apparent half a mile S. of the coal drifts, with again a trace of the Waynesburg (?) Coal below it.

Descending the hill-side to Duncan's (Dunlop's) Creek, the following rocks appear, in all perhaps 100 feet

in thickness. Sandstone, slaty, 6 feet. Interval. *Limestone*, first in the layers, with shale interlaminations; lower part in four layers, 10 feet thick. Sandstone of considerable thickness; brown shale, 6 feet; very black soft shale, 4 feet. Limestone descending to the creek's bed, slates in the upper portion, 10 feet exposed. This limestone-bed is seen several times in the creek, where the road descends to it a second time, 3½ miles from Brownsville; and again at the mouth of the run, a fourth of a mile farther, at Merritstown, where it presents this section, dipping in the direction E. 10° N. Sandstone, limestone, sandstone and shale, some of the layers effervescing with acids; limestone, hard, semi-crystalline, with spots of pure spar: altogether perhaps 35 feet. The limestone forms the creek-bed above the town. Two miles N.E. of Merritstown the small Uniontown (?) Coal appears at half the height of the hill; floor apparently 10 feet of shale.

At *New Salem* are many openings in the Pittsburg Coal and other seams. The former coal is here 8 feet thick.

One and a half miles due N. of *McClellandtown*, on the side of a high hill, the Uniontown Coal-seam is exposed, 2½ feet thick. The hills are here high, and are no doubt based almost immediately upon the Pittsburg Coal.

The Uniontown Coal is again seen, 2 feet thick on the road, 5½ miles S. of McClellandtown. Some distance below it is the Great Limestone, and above it yellow shales compose the hill, which is itself one of a remarkable chain of conical eminences ranging N. and S.

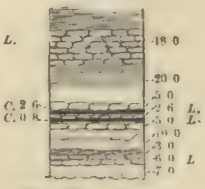


Fig. 539.—Brown's Run.

Half a mile from this point, at the mills upon Brown's Run, and perhaps 150 feet in depth, from the steep banks of the run, the following tolerably accurate section (see Fig. 539) was obtained:—

At the top of the section, *Limestone*, hard, splintery, deep blue, speckled with crystalline sparry limestone, estimated at 18 feet. Blue Shale, lower portion a black slate, with calcareo-ferruginous concretions seen on both sides the creek, 20 feet. *Limestone*, upper part slaty and black; lower part massive, interlaid by calcareous shales, 5 feet. *Uniontown Coal*, 2½ feet; Floor, black Shale, 3 inches. The limestone rests directly upon the coal, the upper 6 inches of which are true bony coal, that is, fine interlaminations of coal and slate. The bed seems to have been much compressed, and breaks out in cubes measuring 2 feet on a side. The lower few inches are not good. *Limestone*, single, hard stratum, 2½ feet. *Coal*, 8 inches. Pure Coal, with a little black slate above and below it about 1 inch. A large part of the bed is pure glassy coal; other parts of it are interleaved coal and slate. Blue friable Shale, thin. *Limestone*, hard, blue, with thin shale interlayers, 5 feet; Thin Shale, 1 foot. Paving Sandstone (of the Brownsville section), distinguished by its peculiar stratification, in bands only an inch or a few inches thick, while blocks of it appear which are 10 feet long, 4 broad, and 4 thick, and lie upon the hill-side. These might be split into flags, as a closed book separates into leaves. The upper layer is here 1 foot thick; then commences the slaty or flaggy portions, 10 feet. Shale, lower part bituminous, 3 feet. Limestone, hard, blue, non-fossiliferous, 6 feet. Sandstone, base of the hill and bed of the run, massive, grey, fine-grained, rather slaty in parts, 7 feet exposed.

At Germantown there are numerous openings in the Pittsburg Seam. For two miles of its course from the river, Cat Run exposes this bed; its thickness is 8½ feet; the clay stratum is 1 foot thick, and near the top the floor of the coal is limestone. Sandstone, light grey, fine-grained, 20 feet; above this, friable slate, containing vegetable impressions, 10 feet: Calamites and other vegetable impressions occur in the solid sandstone. The Pittsburg Sandstone may be traced for 1½ miles below the town, down the W. bank of the river, the latter forming ledges of rock.

No exposures are visible along the W. side of the river in ascending from Brownsville to Crawford's Ferry, 3 miles.

Numerous coal-openings occur within 3 miles of Fredericktown. At Verron's the Pittsburg Coal-bed is 7 feet thick; roof, clay, 1 foot; coal, 18 inches: Pittsburg Sandstone, massive, 30 feet thick. The dip of the bed is said to be due N., or down the river, and its elevation above water-level 25 feet.

Nineteen coal-drifts may here be counted along the outcrop of the Pittsburg Coal. In all, the Pittsburg sandstone is seen resting upon the 18-inch upper member of the Pittsburg Coal, fine-grained and compact, at least 30 feet thick, and overlaid by pyritous brown shale, perhaps 18 feet thick, and this again by 3 feet of sandstone.

In some places the sandstone is much water-worn, as if it had once been subjected to the action of the river-currents standing at a level higher than the present.

At Crawford's Ferry, 2½ miles above Brownsville, the Pittsburg Coal lies in the river-bed; the men employed in mining it are compelled to stand in water up to their knees. Its coal is of the best quality, burning freely, and breaking out of the bed in large masses, some of them 3 feet in length. This quality of the coal mined in running water has been already alluded to, in speaking of a coal-bed in the first sub-basin. The bed has been quarried in this manner a mile along the river bottom for more than twenty years.

One mile above Brownsville a stream comes in from the W. side, upon which the following section was obtained:—

Slaty Sandstone, soft black slate, 5 feet; Black calcareous Slate, 3 feet; *Great Limestone*, 40 feet; Black Slate, 5 feet; Slaty Sandstone, 18 feet; Black Slate, 8 feet; Slaty *Limestone*, 6 feet; Hard blue *Limestone*, 10 feet.—(See Fig. 540.)

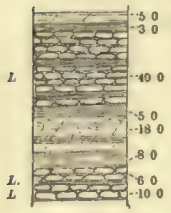


Fig. 540. — One mile above Brownsville.

It is possible that the lower limestone may be a slide upon the hill-side from the upper limestone.

At the mouth of Ten-mile Creek both the Pittsburg Coal and Pittsburg Sandstone are exposed; the latter probably lies near the surface all the way S. to Carmichaeltown, where it is again exposed.

Two and a half miles S.W. of Carmichaeltown, and 1½ miles from the river, the Sewickly (?) Coal, which is occasionally seen to the N. of that place, is wrought at Ingram's Tavern, and yields a good coal. The section (Fig. 541) is as follows:—

Soil, 3 feet; Broken Sandstone, 3 feet; Yellow Shale, 2 feet; *Coal*, tolerably good, 3 feet; Clay Slate, 6 inches; *Coal*, 3 feet. Floor, clay filled with nodules of carbonate of iron (?)

Half a mile farther up the creek, the strata of limestone, 12 feet exposed, lie in the bed of the creek, capped by yellow shales, which underlie the coal-bed, how far is not known.

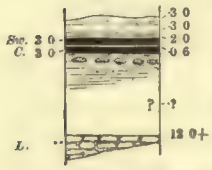


Fig. 541. — Two miles and a half W. of Carmichael.

The coal-bed, at least 4 feet thick, is again seen upon a brook, which enters the creek half a mile farther up. Beyond this point is seen descending from the brow of the hill a tolerably thick bed of limestone; shale and slaty sandstone form a ledge 12 feet thick, then a thick bed of limestone to the creek.

In the neighbourhood of Carmichaeltown there are to the E. three beds of coal.

Upon *Muddy Creek*, three-fourths of a mile from town, the following section was obtained:—

Slaty Pittsburg Sandstone, 32 feet; Friable yellow Shale, 12 feet, apparently much compressed. *Coal*, 3 feet; Clay, 3 inches; *Coal*, 3 feet; Interval, yellow Shale, 40 (?) feet; *Coal*, 2 + feet, 50 feet above the creek.

The coal-bed is wrought for several hundred yards in the bed of the creek, and yields large masses of coal. The dividing-clay is sometimes 6 inches thick, at others it dwindles to an almost imperceptible laminæ of slate.

The Pittsburg Sandstone is beautifully pitted with a thousand holes of every shape. It is compact, and would make a good building-stone.

Under the coal is a bed of shale, 20 feet thick, which contains large quantities of argillaceous iron-ore in flattened irregular nodules as large as a man's fist.

Below the ferriferous shale a limestone-bed is finely exposed in several layers for a mile along the creek, and in the bottom of the shale is a very thin coal-seam.

Sixty or seventy feet above the Pittsburg Coal is another coal-seam imbedded in soft shales, and from 2 to 3 feet thick. At Mr Davidson's bank, this coal-bed (if indeed it is the same) is much thicker.

At the sawmill, lower down the stream, and in the bed of the creek, are shales 12 feet thick, covered by a limestone 15 inches thick. Limestone, perhaps the same stratum, continues for a mile down the stream, covered by shales. At one place, a bed of hard black slate rests upon the limestone in the bed of the creek; this limestone seems here almost like a breccia and might make a handsome marble. The pebbles are of the size of a pea.

Below the last-mentioned locality, a bed of limestone, 20 feet thick, forms the banks of the stream for half a mile, and at last rears two walls from 30 to 40 feet in height, facing each other. This mass of limestone is divided by occasional layers of blue shale. The whole must underlie the double coal-bed before described; and if this be the Great Limestone above the Pittsburg Coal, the seam above it must be the Waynesburg Coal.—(See Fig. 542; observe also the double coal-seam in the Kreb's Knob section opposite Brownsville.)

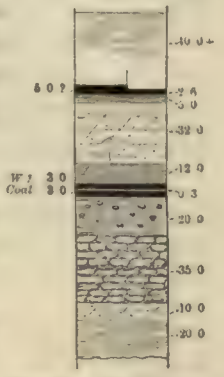


Fig. 542.—Muddy Creek.

When traced still farther down the creek, half a mile or so, the limestone is seen to be supported by sandstone, 10 feet thick; this again by shales 20 feet thick. The shale is dark-blue, hard, laminated, splintery, chopping off like woody fibre; it contains a few round nodules of ore, and presents some slight indications of coal.

This brings us to a point on Muddy Creek within 300 yards of its mouth. The Pittsburg Coal-bed must here be far below water-level.

Upon a run, 2 miles S. of the Muddy Run mouth, and half a mile from the river, are several drifts upon the same coal-bed, divided, as before, into two beds (upper bench, 2 feet 9 inches; lower, 2½ feet), by 1 foot of clay. These drifts, being 30 feet above the bed of the run, are at a still greater elevation above the river.

At the mouth of the Little Whiteley Creek, both the coal and the limestone (20 feet thick) are exposed.

Opposite New Geneva, in the hill back of Greensburg village, the (Pittsburg?) Coal is mined, and a small bed, perhaps 2 feet thick (Redstone Coal), is seen above it. The latter is underlaid by a stratum of sandstone, 3 feet thick, between which and the lower bed are yellow and black shales.

The flat lands, stretching for 2 miles back of the village, are very fertile.

On Whiteley Creek, at Thompson's mills, limestone, 6 feet thick in the creek, supports a bed of coal, 4 feet thick. The limestone is very hard and black inside; but outside it is of a ferruginous brown, and lies in six layers (see Fig. 543). A section of the whole hillside behind the mill, including the above, is as follows:—

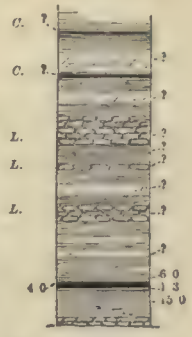


Fig. 543.—Whiteley Creek.

Yellow Shale; *Coal*, thin; Shale and sandstone; *Coal*, Shale; Soft yellow Shale, with sandstone. *Limestone*, thick; Shale; *Limestone*; Sandstone; Limestone in five layers; Sandstone and Shale; Shale, 6 feet. *Coal*, 4 feet; Sandstone, 15 inches; Shale, 15 feet. Limestone in the creek, 6 feet exposed.

The coal-bed, 4 feet thick, is the same that is worked at Ingram's Tavern, and elsewhere in the neighbourhood, appearing upon the road half a mile S. of Ingram's.

No exposures occur on the flat land within 3 miles of Carmichaeltown to the S.; but the knolls are composed of soft yellow shales, with sandstone strata occasionally interspersed.

At New Geneva the hills are about 300 feet in height, and the Pittsburg Coal-bed is opened within 50 feet of their summit, at the Glass Company's drifts. A section of the strata is presented by the quarry on the hill at the mouth of the creek, which, when continued down to water-level, is as follows:—

First drift, Soil, 2 feet; Sandstone and Shale, with thin coal-seams, 12 feet; *Coal*, solid, 6 feet exposed; floor not known. Second drift, Soil, 1 foot; Broken Sandstone, 5 feet; Shale, soft, friable, 3 feet; *Coal*, solid, 8 feet; floor unknown. Shale and Sandstone, 30 (?) feet; Shale, soft, rotten, laminated, yellow, 15 feet. Quarry: Sandstone, compact fine-grained, light-grey, speckled brown—an excellent building-stone—12 feet. Blue Slate, 5 feet; Sandstone layer, 6 feet; Blue Slate, 10 feet. *Limestone*, 2 feet; Shale, 5 feet. *Limestone*, 2½ feet; Shale, 12 feet. *Limestone*, 2 feet; Shale, 3 feet. *Limestone*, 3 feet; Soft Shale, 3 feet. Sandstone and Shale, 10 feet; to Creek-bed, unknown, 20 feet.

The strata of limestone are light yellow, excessively hard, making a dark lime difficult to burn. The intermediate shales are dark, sometimes black, sometimes decomposing into a soft blue clay, and full of calcareous concretions.

Between George Creek and the river, the country is level, denuded of the coal-bed, and covered with fragments of a conglomerate containing white quartz pebbles.

At the sawmill upon George Creek, a fourth of a mile above its mouth, the sandstone quarried in the above section is again seen, with the same limestone-beds below it, containing transparent specks of spar, and is here chiefly of a buff colour. Some bands of the sandstone are imperfect, conglomeritic, containing pebbles of white quartz as large as a pea. The section here is as follows :—

Soil, Shale, 10 feet ; Sandstone, massive ; Blue Shale, 11 feet ; Limestone, 2 feet ; Shale ; Limestone, 4 feet ; Blue Slate, 7 feet ; Yellow Shale, 10 feet ; Limestone, 2 feet. Interval, Limestone (?) feet ; Yellow Shale, with purple spots, 20 feet ; Sandstone and black Slate on the bed of the creek, 6 feet.

Below New Geneva, a grey slaty sandstone occupies the bed of the river, while its shore is strewn with blocks of limestone dislodged from the outcrops, which are upon the hills above. These are excessively hard and heavy, of a black colour within, but turning brown upon the surface by the oxidation of the iron they contain.

At the first run, 1½ miles below New Geneva, a limestone stratum, 10 feet thick, rests upon the sandstone of the river-bed ; it is massive, hard, and heavy. Upon it rest blue laminated slates, 10 feet thick, passing upwards into slaty sandstone.

A few hundred yards up the run is seen a coal-bed, 1 foot thick ; floor, slaty sandstone in the run ; roof yellow shale, 12 feet, passing upward into sandstone layers, followed by shale, and all capped by 2½ feet of limestone stratum at the summit of the hill-side. This latter limestone is doubtless one of those given in the section (Fig. 543).

Returning N. into Washington County, and ascending Mingo Creek, below Monongahela City, we find an opening a fourth of a mile from the river in the Pittsburg Coal-bed, which seam disappears beneath the creek-level at a point three-fourths of a mile farther up the creek.

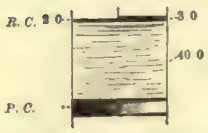


Fig. 544.—Mingo Creek.

Two miles W. of the last locality, and upon the N. fork of the Mingo Creek, a small coal-bed (Redstone Coal) passes also into the bed of the creek. This is no doubt the same small bed that is seen above the Pittsburg Coal, at Robbstown ; it is here about 40 feet above that seam ; is between 2 and 3 feet thick, and nearly horizontal.—(See Fig. 544).

The road from Brownsville to Pittsburg ascends the Little Mingo Creek, and gives exposures that are worthy of attentive examination. The Pittsburg Coal-bed is here seen opened at the steam-mill, and may thence be traced N. through Findlaysville, as it gradually and regularly rises to the elevation which it has assumed upon the Monongahela Cliffs opposite to Pittsburg City. The Great Limestone is thus also seen to spread to a considerable distance N. of the National Road, enclosing within its convex outcrop the major part of Greene and Washington counties. Three miles from Pittsburg, on the turnpike to Washington, a quarry has been opened upon a limestone-band above the Pittsburg Coal.

There is an opening upon the Pittsburg Coal-bed one mile W. of Cannonsburg on the turnpike, and another up the valley of the N. branch of the Chartier Creek, distant one mile due West of the first locality ; the plane of the bed has risen (Westward) by measurement about 40 feet.

One mile W. 15° S. of the last, it is again opened nearly at the same level.

Half a mile due West of the last opening, the coal disappears beneath the bed of the creek.

Where the creek comes to a head, and forks as two small rivulets, the soil from the Great Limestone composes most of the hill-sides as they gently slope outwards towards the general elevation of the country, which probably in no place is more than 200 feet above the water at this head of the creek.

Large blocks of coarse sandstone are seen upon the ridge or high lands separating the head-waters of Chartier and Cross creeks.

North of West Middleton, the shales above the Pittsburg Coal abound. Upon Cross Creek, 3 miles to the N. of the town, the Great Limestone is exposed in its lower members about 20 feet above the water-level ; the hills around being little less than 200 feet in height, but gently sloping, and of irregular form.

Descending Cross Creek, the Pittsburg Coal-bed soon appears under the following subdivisions :—

Coal, 2 feet ; Clay, 2½ feet ; *Coal*, 4½ feet.

Near Plumer's mill, one and a half miles farther down the creek, the Pittsburg Coal is wrought at an elevation of 100 feet above the water. Beneath it are seen limestone and very massive sandstone strata.

It is opened again one and a half miles W. of the last; the hills rising 200 feet above the plane of the bed. This is half a mile E. of the Virginia State line.

At the mouth of Buffalo Creek, on the banks of the Ohio, the coal-bed is opened, the hills rising above it 80 feet or more.

The Great Limestone strata are traceable the whole distance from Washington to Wheeling. For 18 miles W. of the former place, along the National Road, the country is very hilly.

At a point 4 miles W. of Washington, several quarries are opened in the Great Limestone. Some of its strata are of a very dark colour, approaching black, which recalls the fact of the presence of the Sewickly Coal-bed, at certain localities, in the very middle plane of the calcareous mass.

Behind the town of Wheeling, at the first milestone, upon the hill-side, the same strata appear very compact, and 30 feet in thickness. The successive layers are parted by calcareous shales.

Ascending Wheeling Creek, the Pittsburg Coal first strikes the bed of the stream, and afterwards the Great Limestone does the same, exhibiting the *Sewickly Coal* within it 2 *feet thick*, at a place a short distance W. of Fridelphia.

At West Alexandria the inhabitants have command of the Waynesburg Coal-bed, but prefer to use the coal from Mr Groding's opening upon the Pittsburg Coal, 7 miles from Wheeling.

Throughout all this country, it will be found correct to say that a great bed of alternating sandstones and shales overlies the Great Limestone: it contains two coal-beds.

From Washington to Waynesburg, upon the National Turnpike near Washington, the Great Limestone is opened in a quarry.

Three-fourths of a mile S. of Martin's Tavern, where the Waynesburg Road leaves the National Turnpike, two sandstone strata are visible 20 feet asunder; the lower one is 5 feet thick, the upper 7 feet; they evidently overlie the Great Limestone, and may be the equivalent of the "Paving-stone" of the Brownsville section. The upper stratum is a compact mass of a greenish-yellow colour, and is homogeneous, fine-grained, and apparently contains numerous minute scales of mica. Part of it breaks into handsome slabs 3 inches in thickness. It lies about 40 feet below the general surface of the country in this neighbourhood.

The Great Limestone is exposed in the hollow, three-fourths of a mile S. of the above locality. Four feet of its upper portion are exposed, and over this lies shale, brown and friable, 20 feet; then sandstone, 5 feet, which may be the lower of the two layers above described: above it there are indications of a coal-seam.

As the bed continues S., these rocks repeatedly expose themselves to the day. At a distance of 1½ miles the road leaves the hollow and ascends a hill, over the sides of which are strewn blocks of coarse brown sandstone, and at its top the stratum appears in place. At the very summit, a hard blue limestone, with a coping of soft yellow shale, is seen. From thence to Amity similar appearances present themselves, but all exposures upon a broad water-shed like this are unsatisfactory, and lead to few results.

The nearest important coal-banks are 4 miles distant from Amity, upon Ten-mile Creek. Three-quarters of a mile S. of Amity, where the road to Waynesburg descends a second time to the creek, is a coal-bed 3 feet thick, with floor of shales and slaty sandstone, 10 feet down to the creek's bed. Large blocks of limestone, 18 inches thick, lie strewn about, having fallen from above. The coal is so poor, being divided by numerous slate-bands, that it is not worth working. The limestone begins to appear about 10 feet above the coal, and seems to be a thick mass when traced up the run. Much shale lies between its layers.

Three miles from Amity the same limestone is seen twice upon a run rising 100 feet above its plane: the hills offer no exposures.

The country from hence to Waynesburg is hilly, not well cleared, and furnishes no good exposures.

Waynesburg.—The following section was measured upon the S. fork of Ten-mile Creek, a mile below the town, in descending order beneath the soil:—

Slaty Sandstone ; thin blue Slate, 15 feet. *Limestone*, 3 layers, 4 feet. Shale, soft, bluish-black, 4 feet. *Limestone*, three layers, 4 feet. Blue Shale, with row of hard limestone blocks, 3 feet 2 inches. *Coal*, impure, 20 inches. Blue Shale, friable, full of calcareous concretions, 7½ feet. Sandstone, massive, 2 feet ; slaty, 2 + feet.

The Waynesburg Coal-bed is exposed for 2 miles along Laurel Run, which enters the creek from the S. 2 miles below the town.

At the bank at the mouth of the run are seen slaty sandstone, 20 (?) feet ; Brown slate, hard, and in part friable, 3 feet ; *Coal*, in the water, 2 feet exposed.

The slate above the coal is very hard and ferruginous, shows surfaces of about 3 feet in length, and 6 inches in breadth, and contains beds of a true conglomerate, full of rounded pebbles, showing the action of water at the time of its original deposition. It contains flags of an impure pyritous iron-ore, 6 inches long by 1 inch thick, and of silvery lustre. These are abundant in the shale that immediately overlies the coal, which, as here exposed, is probably but the upper member of the bed separated from the lower by an undermining of clay-slate.

Ingram's Coal.

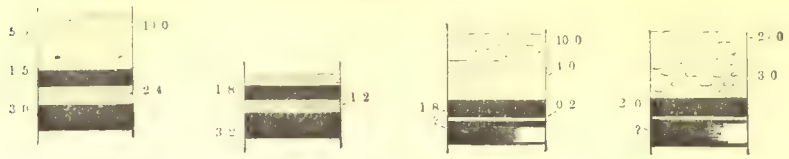


Fig. 545. Fig. 546. Fig. 547. Fig. 548.

The strata undulate irregularly, and at a coal-opening one mile higher up the run, dip 10° N. 30° W. Here a section of the bed reads,—

Sandstone, 10 feet ; Shale, very brown and friable, 4 feet. *Coal*, 20 inches ; Clay band, 8 inches ; *Coal*, 1 foot exposed.

The whole bed is opened at the next bank, and seen to be 6 feet thick ; thus :—

Coal, 20 inches ; Clay, 14 inches ; *Coal*, 3 feet 2 inches.

The pure soft clay between the parts of the bed varies so as to be sometimes but 6 inches thick, and would probably make good fire-brick. The coal is very good.

At Ingram's, half a mile higher up, the dip is S. 20° W., and a section beneath the sandstone and shale (10 feet) reads as follows :—

Coal, 17 inches ; Clay, 2⅓ feet ; *Coal*, 3 feet.

At another opening the sandstone is exposed 10 feet, and the shale is but 5½ feet thick. The various measurements are given in Figs. 545, 546, 547, and 548.

A coal-bed, imperfectly displaying 3 feet of coal, has been opened at the top of a hill just S. of the creek, and about a mile E. of Laurel Run, upon which the openings last mentioned are situated. If this be the Waynesburg Coal-bed, then, as it is so much above those openings, and at the same time dips Eastward, we may look for a slight anticlinal axis traversing this region between the two localities.

CHAPTER XXIX.

COUNTRY SOUTH OF THE CONEMAUGH, IN THE FIRST AND SECOND BASINS, IN SOMERSET AND FAYETTE COUNTIES.

As this region has been more minutely described in Subdivision II. of Book IX., or in the preliminary general description, than other portions of the great bituminous-coal country, little remains to be added except such groups of vertical columns as may serve to illustrate the text. The same order that was then adopted will therefore now be observed in describing the sections of the strata.

First or Salzburg Subdivision of the First Basin.—The following section of the strata, on Elk

Lick Creek, in the S. part of Somerset County, was referred to in the general description—(see Figs. 549 and 550) :—

Great Limestone, several feet of it left upon the top of the hill between Elk Lick Creek and Castleman's River. *Coal*, thickness unknown (Uniontown Coal). Interval, Sandstone 50 feet. *Coal*, large bed (Sewickly Coal) ; Coarse Pittsburg Sandstone, 25 + ; Black Shales and Slates, 15 feet. *Pittsburg Coal*, 9 feet. Interval, in which iron-ore fragments lie scattered, 60 feet ; Black Slate, 6 feet. *Barren-Measure Coal*, 1 + foot ; Sandstone, 30 feet ; Black Slate, 20 feet. *Barren-Measure Coal*, 1½ feet ; Black Slate, 35 feet ; Sandstone, 12 feet ; Slate, 1 foot ; Black Slate, 1 foot. *Barren-Measure Coal*, 2 inches ; Olive Slate, 10 feet. *Elk Lick Coal* (in the ravine back from the W. side of the creek), 4 feet ; interval, pink shale, clay, 12 feet. *Coal* (not good), 12 inches ; Shale, including blue carbonate of iron (in the road), from 3 to 4 inches, 10 (?) feet. *Coal* (?) ; interval, of which the lower part is shale, black and buff slate, 30 feet. *Upper Freeport Coal*, not good, and in two beds, 2 feet. *Freeport Limestone*, 5 feet ; Coarse Sandstone, 25 feet.

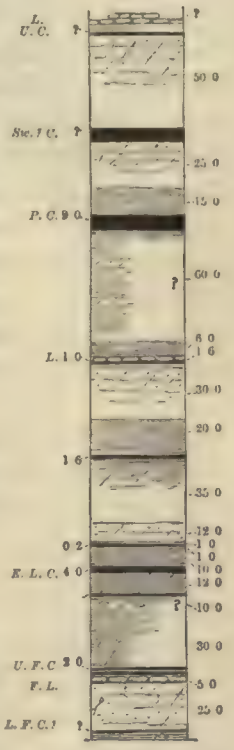


Fig. 549.—Elk Lick Creek.

Lower Freeport Coal (?).—Massive sandstone to the bed of the creek, at a point half a mile below the old waggon-shop. If the limestone seen at the old salt-boring be the Freeport Limestone, the section (as given by Mr Jager) of rocks bored through will continue as follows (see Fig. 550) :—

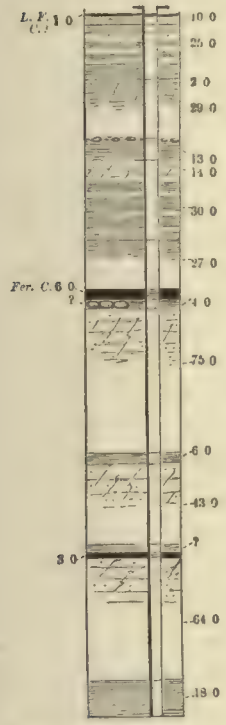


Fig. 550.—Elk Lick Creek, Salt Well.

Freeport Limestone, black, and slate, 2 feet ; Interval, 18 feet. *Lower Freeport Coal*, 1 foot. Blue Slate, 10 feet ; Dark Shale and sandstone, 25 feet ; Fire-clay, 2 feet ; Soft argillaceous Shale, 29 feet ; Layer of Iron Ore ; Black Slate, 13 feet ; Grey Sandstone, 14 feet ; Argillaceous Shale, 30 feet ; Black Slate, 27 feet ; Iron Ore, finest quality of blue carbonate, compact layer, 7 inches ; Slates, 12 inches. *Coal*, 6 feet ; Black Slate, 4 feet. *Tionesta* (?) *Sandstone*, 75 feet ; Dark Slate, 6 feet. *Seral Conglomerate* (?) 43 feet ; Shale (?). *Sharon* (?) *Coal*, 3 feet ; Sandstone, 64 feet ; Black Slate, 18 feet.

The Pittsburg Coal-bed has been opened on Keim's land, and on that of Mr Livergood. On Piney Run, 2½ miles S. of Salzburg, there is a slightly fossiliferous limestone 10 feet thick, and dipping N.W : it has been quarried for the National Road. Its roof is a beautifully-variegated sandstone, above which lies a red calcareous sandstone. For 60 feet beneath the limestone occur sandstones, and half a mile down the run appears a fossiliferous limestone and slate. Precisely similar appearances occur in the valley between Negro Mountain and Winding Ridge, in a field. Near Berlin, below the town, a coal-bed about 5 feet thick has been opened, with a floor of black slate 6 inches thick. About 30 feet below it occurs a bed of nearly equal size, and another still lower in the series. A bed of limestone, supposed to underlie the middle coal, would identify it with the Upper Freeport Bed (see Fig. 551).

This limestone (or perhaps a lower one) is seen upon Castlemary River, at the mouth of Buffalo Lick Creek, where it is 5 feet thick, and has a coal-bed over it.

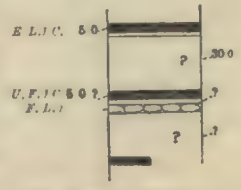


Fig. 551.—Berlin.

The most important deposit of iron ore hitherto brought to light, in this basin, is that of the Elk Lick Falls above referred to. There are here three layers of ore. The lowest, measuring 1 foot 4 inches, is a nearly solid bed, merely divided into blocks rounded at the edges. The other two overlie the first at a distance of 2 feet, and together contain as much ore as would be equivalent to a solid band about 4 inches thick. An ore, supposed to be the same band, was discovered 2 miles farther down the creek. Several thin seams of ore likewise occur on Tubmill Run, half a mile below the sawmill, but they are not of sufficient importance to attract attention. At another place on the same stream,

ore is said to have been opened in a position 25 feet below a coal-seam 3 feet 3 inches thick, identified with that at the falls: this ore is stated to amount to 15 inches.

The falls of Elk Lick are a succession of many small and rapid leaps, winding in a long descent through a narrow irregular channel in the sandstone; the rocky walls sometimes overhang the stream, which is then darkened by the meeting boughs of the trees and the tangled stems of the laurel, which in many places make an almost impenetrable thicket. The defile itself is alternately contracted into short narrow passages, and widened into more spacious chambers. The whole scene, though of limited extent, is striking for its novel and picturesque beauty, and in perfect keeping with the wilderness around.

Second and Third Divisions of the First Basin.—On the top of the Alleghany Mountain, 2 miles S. of the Old Portage Railroad, is a bed of blue flag-limestone from 5 to 6 feet thick, supposed to be the Ferriferous Limestone.

The following section (Fig. 552) is descriptive of the strata exhibited on the Alleghany Mountain, at the Pennsylvania Railroad Tunnel:—

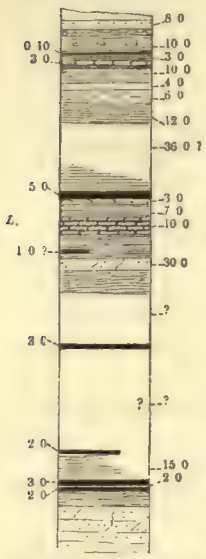


Fig. 552. — Alleghany Summit, Pennsylvania Railroad.

At West End of the Tunnel.—Soil; Argillaceous Sandstone and shale, 8 feet; Sandy Shales, with balls of rough ore, 10 feet. *Coal*, 10 inches; Calcareous Fire-clay, 3 feet; Sandy Shales, 10 feet; Light grey Sandstone, 4 feet; Fire-clay Shales, 6 feet; Olive Shale and argillaceous sandstone, 12 feet to railroad-level; Interval, 40 (?) feet.

East End of the Tunnel.—*Coal*, 5 feet, said to be 80 feet below the upper coal in the air-shafts; Coarse Fire-clay, 3 feet; Sandy Shales, 7 feet; Argillaceous Limestone, some beds pure, 10 feet; Sandy Shales and argillaceous sandstone, 30 feet; Interval, 30 (?) feet. *Coal*, 3 feet; Interval, 80 (?) feet. *Coal*, 2 feet in the railroad-cutting near Bennington; Shale, 15 feet. *Coal*, 3 feet 6 inches at Bennington; at R. Lemon's, foot of Plane No. 6, 3 feet coal, 1 foot slate, 2 feet coal; Shales, 10 feet; Sandstone, including beds of blue slate, 45 feet; Black Slate; Ferruginous Shale. Still lower a coal-seam 1½ feet thick is said to exist.

The large bed cut at the E. end of the tunnel contains two bands of slate, but nearly 5 feet thickness of coal. It is mined at the tunnel by the Alleghany Coal Company. The coal is exceedingly columnar and soft: the fissures are at right angles and parallel with the strike. The same bed is wrought by Samuel Lemon at the top of Plane No. 6; its dimensions there are as follows:—

Coal, 2 feet 10 inches; Slate, 1 inch; Coal, 16 inches; Slate, 3 inches; Coal, 6 inches; dip, 2° to 3° N.W.

It is also wrought by Mr Bingham at the foot of Plane No. 5; also by Moore and Ray, Dougherty and others, farther W.

The lowest coal of the section is that wrought by Messrs Lemon and Miller, near the foot of Plane No. 6. A slate band from a few inches to 2 feet in thickness divides the top bench 3 feet thick from the bottom 2 feet thick. At Bennington the same bed is wrought to supply Harriet Furnace. It is there 3 feet 6 inches thick, and is overlaid at 15 feet distance by a smaller bed from 18 inches to 2 feet in thickness.

Near Lilly's Station of the Pennsylvania Railroad, a seam, equivalent, we think, to the Big Coal of the tunnel, and 4 feet 4 inches in thickness, is mined and coked by Mr Tiley. It is overlaid by blue shaly slate containing some nodular iron-ore, and underlaid by the following strata:—

Slate, &c., 20 feet; Limestone, quality not tested, 10 feet; Fire-clay, 2 feet; *Coal*, 2 feet; Fire-clay, 2 feet; Limestone.

Tiley's Seam contains 1 inch of slate 18 inches from the bottom; it is worked by Michael Myers, about a mile W. of Lilly's; also by Stephen Myers and David Fox, on land owned by Mr White.

At the head of the Old Portage Plane, No. 3, a seam of coal 18 inches thick is clearly exposed, underlaid by a band of limestone of about 4 feet in thickness. This small seam clearly overlies Tiley's by as much as probably 50 or 60 feet. In a cutting at the foot of Plane No. 3, Tiley's Bed, and also two subjacent seams, are brought to view. The first of these measures 2½ feet in two benches: it is underlaid by fire-clay, and a

bed of impure limestone and shale containing nodules of iron ore, to a depth of about 40 feet. A bed of coal 2 feet in thickness succeeds, underlaid by slate.

At Plane No. 2 a limestone appears, judged to be that just described at the head of Plane No. 3.

Between Plane No. 2 and the village of Jefferson no productive coals are visible along the railway, the principal exposures consisting of fine blue sandstones and shales. In the latter an 8-inch seam of coal is visible at one locality. Approaching Jefferson on the Portage Railroad, one or two important beds of limestone outcrop: the upper of these is 3 feet thick, and somewhat slaty in character, but the lower presents a thickness of 10 feet. Between the two a thin bed of bituminous shale is interposed. The dip is about 3° W.

Resuming the line of the Central Railroad from Jefferson, the exposures consist at first of olive and brown shales, capped by sandy shales and fire-clay containing some nodular iron-ore. This fire-clay occupies the centre of the basin on the road. The synclinal axis of the basin thus alluded to is little less than a mile W. of the village of Jefferson. The dips on its W. side amount to about 8° in a direction S. 75° E. This inclination of the beds, it will be observed, is steeper on the W. side of the axis, and speedily brings to the surface the limestone and thin coals seen E. of Jefferson.

The lower coals are nowhere visible on the railroad, but they outcrop doubtless at points not exposed by any cuttings in the railroad or vicinity. An opening has been made by Mr Croyle on a coal 4 feet thick, at a point about three-quarters of a mile N.W. of Croyle's Mills (now called Summer Hill). This opening is high on the hills, probably upwards of 100 feet above the level of the creek at Summer Hill. At Summer Hill Station the strata exposed are olive sandy shales containing some iron ore—not enough, however, to be profitable—underlaid by a thin band of limestone and a small coal. The only workable seam of coal seen in the neighbourhood of the railroad is about a mile W. of Summer Hill, where a 3½-feet seam was opened some years ago on the line of the Portage Railroad.

At the South Fork Station red shales and sandstones begin to make their appearance; these are succeeded by cross-bedded grey sandstones—some beds very coarse and pebbly—to the Big Viaduct, where Umbral red shales and an underlying bed of calciferous sandstone are elevated to the creek-level by an anticlinal arch. The inclination of the strata on both sides of the viaduct axis is very gentle, not exceeding 2° or 3°. The consequence is, there are no exposures of workable coals until the vicinity of Conemaugh Station is reached. Here a coal 3 feet in thickness is opened near the station, and higher in the hill a seam of coal underlaid by hydraulic cement, and known as the cement seam of Johnstown.

The accompanying section (Fig. 553) will exhibit the succession of strata in the vicinity of Johnstown :—

Limestone, 1 foot 6 inches to 2 feet; interval. *Coal*, 6 inches; interval, 12 feet. *Iron Ore* in two bands, 2 feet to 3½ feet; interval, 60 feet. *Coal*, 3 feet 8 inches; interval, iron ore, &c., 45 feet. *Coal*, 2 feet 6 inches; Slate, 18 inches; Limestone, 3 feet; Shale, 28 feet. *Coal*, 8 inches; Shale, 12 feet. *Coal*, 3 feet 6 inches; Fire-clay, Stigmaria rootlets, 1 foot; Calcareous hydraulic cement, 4 to 5 feet; Shale and Fire-clay, 10 feet; Shale, including 6 to 12 inches of iron ore, 50 feet. *Coal*, 3 feet 3 inches, at or just below water-level; interval, including two thin coaly bands, 45 (?) feet; Seral conglomerate.

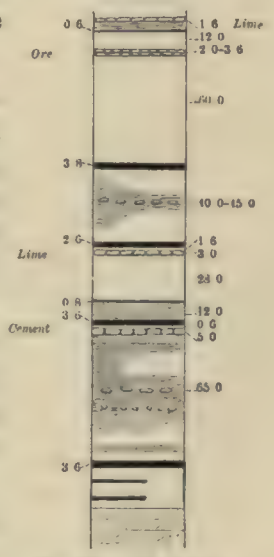


Fig. 553.—Johnstown.

By adhering to the limestone bands as fixed horizons, we are here greatly puzzled to affix names establishing the identification of the coal-beds. Should a limestone stratum be found under the upper 3 feet 8 inch coal, and that under the next subjacent coal prove only local, the difficulty vanishes, and we have the proper seams of the Freeport group.

The iron ore near the top of the section is worked extensively at the Cambria Iron-works near Johnstown.

The stratum overlies the highest workable coal about 60 feet; it is therefore high in the hills above Johnstown. Although mined for a long time on the N. side of the Conemaugh, it has not been detected on the S. side in its full thickness: examinations have been made for it. The stratum has a roof

and floor of slate, and is divided into two bands differing in character and thickness. The upper band varies in thickness from 18 inches to 2½ feet. Under good cover it quarries in square blocks. It is close-grained, compact, dove-coloured, oxidises at the outcrop, forming a Spanish brown, and at the outcrop is always shelly. Analyses prove it to contain from 51 to 52 per cent of iron. The lower band, separated from the upper by a thin band of bluish indurated fire-clay, varies in thickness from 6 inches to 2 feet; colour, a light-blue limestone, weathering white on the surface. It is worthy of remark that where the upper band thins the lower thickens, and *vice versâ;* so that the average total thickness of the band is from 2 to 3½ feet. The Cambria Iron Company work this ore with coke, and sometimes without limestone.

Between Johnstown and the flank of Laurel Hill, the Coal-measures occupy a flat shallow basin. On the Eastern side of the basin the dips are very gentle, so that the Johnstown ore-band occupies a high position in the hills bordering the river. The bottom rock of the Coal-measures, in the form of a coarse-grained grey sandstone, 40 feet in thickness, rises to the surface near the seventy-sixth mile-post of the railroad.

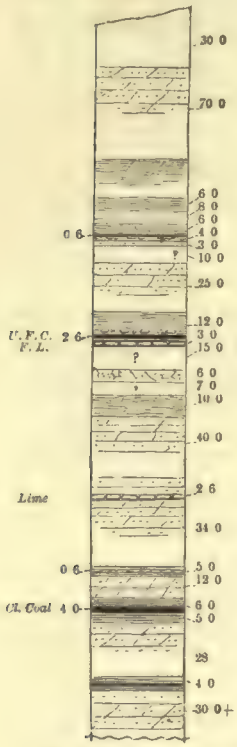


FIG. 554.—Stony Creek.

On the E. slope of Laurel Hill, 2 miles from Cambria Furnace, red iron-ore is found and wrought, associated as follows:—White Sandstone, 10 feet; Red Shale, 8 feet; Red Ore, 16 inches; Blue and red Shale. This Umbral red ore is mined and used at Laurel Hill Furnace, 6 miles S.W. of the Conemaugh, on the N.W. dip of Laurel Hill. The bed is 12 or 18 inches thick, capped by red shale, and underlaid by white and red clay. A thick-bedded white sandstone is cut through to reach the ore beneath, which makes a good metal. A section was made on Stony Creek, at the Red Bridge, above the mouth of Ben's Creek, Fig. 554; it reads as follows:—

From top of the hill to a terrace, perhaps containing coal, 30 feet. Thin-bedded coarse Sandstones, under it large masses of Shale, in all 70 feet; Brown and black Shales, 6 feet; Buff and olive Shales, 8½ feet; Green Slates, 6 feet. *Coal*, 6 inches; Fire-clay and Shale, 4 feet; Sandstone, 3 feet; Unknown, 10 feet; Sandstone, thin-bedded, 25 feet; Slates and Shales, 12 feet; Ore stratum, 3 inches; Fire-clay, 8 inches. *Coal*, 2½ feet; Black Slate, 6 inches. Limestone, 3 feet; Unknown, 15 feet; Massive Sandstone, with some shale, 6 feet; Unknown, 7 feet; Blue and grey Shales and slates, 10 feet; Thin Sandstones, 40. Limestone, 2½ feet; Sandstone, massive in lower part, 34 feet; Blue Slate, with half an inch of limestone, 5½ feet; Massive Sandstone, 12 feet; Shale, 2½ feet; Black Slate, 3 feet; *Clarion* (?) *Coal*, good, pyritous, 3 feet 9 inches; Black Slate, 5 feet. Massive Sandstone (at the abutment of the Red Bridge), 28 feet; Black Slate, 4 feet. *Brookville* (?) *Coal*, 12 inches; Sandstone, 30 feet exposed. In all, 390 feet of rocks.

A section made half a mile W. of the latter, and upon the slope of the "Hog's Back," reads as follows, and is exhibited by Fig. 555:—

Sandstone, flaggy, 30 feet. Sandstone, massive, and Shale, 60 feet. *Coal* (?) terrace; Sandstones, thin-bedded, no exposures, 45 feet. *Pittsburg* (?) *Coal* (?) terrace; no exposures for 150 feet, except some coal-slates and brown ferruginous shales; Sandstone, massive and flaggy, 36 feet; Olive Shale, 6 feet; Dark-blue Shale, 4 feet; Sandstone, with some balls of ore, 25 feet; Dark Shale, 3 feet. Iron ore, nodules in contact, 12 inches. Limestone, hard and ferruginous, 2½ feet; Fire-clay, 2½ feet; Olive Shale, 4 feet; Coarse grey heavy Sandstone, 11 feet; Black Slate, 11½ feet. *Coal*, 4 feet; Slate, 3 inches; Limestone, 6 feet; Blue-black Shale (ore 5½ to 12 inches), 8 feet; Dark-blue Shale (ore 1 or 2 inches), 7 feet; Shale (ore one band), 1 foot; Thin sandy Slate, 13½ feet. *Coal*, 9 inches; Shale, blue and sandy (ore two bands, 2 feet apart, 2 inches thick each), 14½ feet. In all, 445 feet.

The structure of this section seems to identify its coal and limestone with the ferriferous coal and limestone of the Clarion group. The dip known is Westward (in one spot 11°), and they may belong to the Freeport group.

On Livergood's land is a coal-bed 4 feet thick, with large quantities of iron ore in a 7-feet stratum of shale above it; upon this rests a massive sandstone stratum; and 60 feet farther down in the series is another coal-bed, unexplored.

Two beds of coal and limestone, each 3 feet thick, occur 1½ miles N.E. of Johnstown; ferriferous slate here overlies the coal.

The same slate, exceedingly ferriferous, occurs above the coal and limestone on Stony Creek, 2½ miles above Johnstown. The column (Fig. 556) represents a section constructed between the confluence of Paint Creek with Stony Creek, and the Paint Creek Falls, and reads as follows:—

Sandstone, 5 feet, including scattered balls of iron ore of no great value, but amounting in all to perhaps 12 inches in thickness. Iron ore, nodular, 12 inches. Sandstone, 3 feet. Iron ore, nodular, good, 5 inches; Sandstone, 2 feet. Iron ore, balls close and persistent, good, 4 inches; Shaly Sandstone, 9 inches. Iron ore, compact stratum, of excellent quality, 2½ inches. Sandstone, 6 inches. Iron ore, compact stratum, good, 1½ inches; Fine-bedded Sandstone and Shale, 6 feet; Shale and Slate (ore scattered throughout, of the finest quality, and in all perhaps 6 inches), 4½ feet. Slate, black laminated, 2½ feet; *Clarion* (?) *Coal* (dipping S.E. 3°), 3 + feet; Sandstone, massive, and also thin-bedded, which forms the cascade, 40 + feet. Level of bottom land, where perhaps a thin coal-bed exists; Sandstone, skirting the creek, with cliffs, massive, 40 feet; Iron ore, finest quality, of blue carbonate, compact layer, 7 inches. Massive Sandstone, also thin-bedded, including 8 inches of coarse nodular carbonate of iron, 30 feet; Shale, 5 feet; Sandstone to the mouth. The rock is falsely bedded, indicating variable currents of deposition; it frequently presents conglomeritic aspects, and may be the Seral conglomerate. The falls are perhaps 10 feet high.

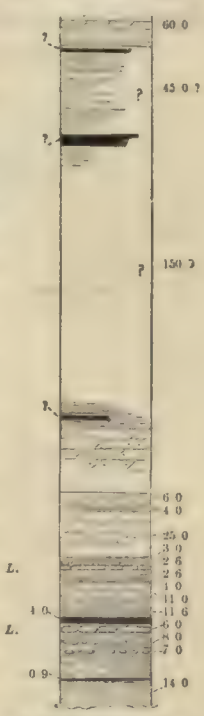


Fig. 555.—Below Red Bridge, on Stony Creek.

At the forks of Paint Creek, as the section exhibits, there is at the sawmill an abundance of good ore, 2 feet thick, partly "rock ore," or continuous strata, and partly very continuous ball-ore, within a space of 8 feet. Besides these there are beds of large nodules in the 5-feet sandstone roof, and a very good ore in the 4½-feet shale below. The lower band farther down the creek affords masses of many pounds' weight, lying almost loose in the bed of the creek; but it cannot be mined, because it seems to be included between hard massive sandstones. This may prove, upon trial, to be merely an appearance due to the enormous amount of fallen rocky matter which lines the sides of the gorge through which the stream now flows.

Two coal-beds and two limestone-beds outcrop upon the hill at the dam on Stony Creek, 2½ miles below Paint Creek. The section is as follows:—

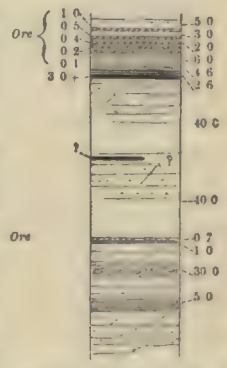


Fig. 556.—Paint Creek.

Sandstone in fine slabs, forming the summit of Bell's Knob, near Rhoad's Camp Creek, 40 feet. *Coal terrace and outcrop;* Shales, olive (fragments of iron ore), 18 feet. *Coal* (?) *terrace* (little black Slate); Shales, olive, 60 feet. *Coal* (?) *terrace;* Sandstone, blackish, 15 feet; Shales, pink, yellow, olive, with fine-grained Sandstones, 75 feet. *Coal terrace,* 10-feet slope, in which occurs either the large bed mined on the opposite side of the creek, or else the small bed opened in the mill-race, 1 foot thick; Seral conglomerate, exposed, 70 feet.

From the top of Link's Hill, upon the left bank of the creek, we have the following section—(See Fig. 557):—

Coal (?) *terrace,* 60 or 80 feet below the hill-top; Sandstone, 35 feet; Olive Shale, sandstone, and some black slate, 10 feet; *Brookville* (?) *Coal* (dip. S.W. 10°), 5 feet.

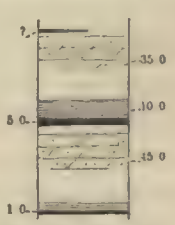


Fig. 557.—Rhoad's Camp.

This may be the bed of that terrace above alluded to, which appears 50 feet above the road leading Southward to the Somerset Road, in which case the S.W. dip must be very local, and the section continues downwards, thus:—Sandstone, 45 feet.

Coal (?) terrace, with springs running up through the orchard, and doubtless the same little coal-bed which

is opened in the mill-race. This coal-bed appears in the run back of Mr Link's fields, where above it occurs a band of very fine ore 3 inches thick.

In the narrow middle trough of Somerset County, the Clarion Coal-bed (see Fig. 558), has been developed in may places along Little's Run, 4 miles N. of Stoystown. The bed here contains 5 feet of good coal. Separated from this by 100 feet of strata, we find the Ferriferous Coal-bed here 2½ feet thick, and resting immediately on the Ferriferous Limestone, from 3 to 4 feet thick. The place where this appears is 2½ miles N. of Stoystown, at Lohr's limestone quarry.

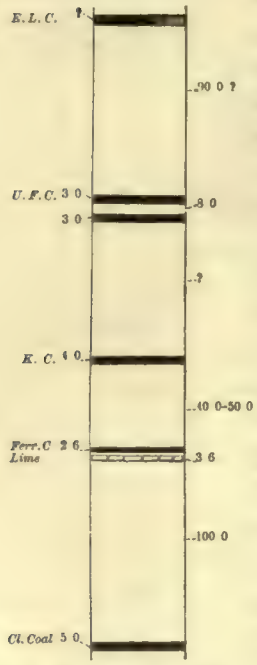


Fig. 558.—Stoystown.

The Kittanning Coal-bed is worked by Mr Kimmel at Stoystown, where it is 4 feet thick, and overlies the last at an interval estimated to be from 40 to 50 feet.

The Upper Freeport (?) *Coal-bed* is divided, in the vicinity of Stoystown, into two beds 8 feet apart, and each of them 3 feet thick. The lowest of these is worked on a little branch of Oven or Breastwork Run, about 2 miles N.E. of Stoystown.

There is an outcrop of apparently a large coal-seam on the turnpike E. of Stoystown, overlying the uppermost of these beds at a distance of about 90 feet. This is probably the Elk-Lick Coal-bed. Benches or indentations on the surface indicate the existence of two or three other coal-beds between this and the summit of the highest hills, though the localities where the coal has been opened are so scattered and few as to interfere with all attempts at placing them accurately in the series.

A small quantity of iron ore reposing upon the Clarion Coal at the railroad summit, and near Summer Hill, becomes in the vicinity of Stoystown a regularly-formed band of nodular ore. This is evident from fragments seen in the bed of the small creek on which Little's Coal-bed is opened.

A band of sandstone seen over the same coal-bed at Plane No. 1, and at Stony Creek bridge, appears in corresponding place over Little's coal.

Two small beds are seen under the Ferriferous Limestone, 3 miles N. of Stoystown.

The 30-feet sandstone over the Ferriferous Coal makes its appearance here.

Although the old Shade furnace was supplied with a poor ore, which led to its abandonment, there occurs an abundant deposit of pretty good ore, discovered 2 miles farther up the stream. It is in coarse nodules, some of which are of great size, though a small layer of a finer quality, and a few inches thick, overlies it in a compact shale at a distance of 4 or 5 feet. Between 10 and 15 feet above this latter layer there is a thin seam of coal about 16 inches thick. No other coal-bed, and unfortunately no limestone, has yet been, or is likely to be, discovered in this immediate neighbourhood. Notwithstanding the scarcity of these materials, the spot seems a sufficiently favourable one for the manufacture of iron—the ore appearing to be good and abundant, and fuel, both charcoal and mineral coal, being procurable at no great distance: a small furnace has therefore been erected at this place. The geological situation of this ore is in shale, resting directly on the upper surface of the coarse Seral conglomerate. Indications of the same ore occur in a corresponding position, the whole way from the old Shade furnace to the mouth of Shade Creek.

At Lambert's mill there is a bed of coal 3 feet 7 inches thick, and over it 12 feet of dark shale, containing a yellowish fine-grained ore, in flattened nodules, weighing from 10 to 20 lbs. The aggregate thickness of the ore, in the whole 12 feet of shale, is estimated at 2 feet. Ten or twelve feet beneath the coal-bed lies a band of limestone, in thickness about 2 feet.

A locality important for its iron ore is on Wells' Creek, 5½ miles N.E. of Somerset. Here a layer of limestone occurs in the bed of the creek, resting on a blue sandstone, which forms the bottom of the channel. The limestone is said to be in all 6 feet thick, though only 2 feet are exposed. A coal-bed showing a promising outcrop appears a few feet above the limestone, and indications of other coal-seams present themselves farther up the hill. One of these upper beds has been worked. At the top of the hill, nearly 300 feet above the stream, in a sterile tract of a few acres, many pieces of a very rich red ore have been met with, but the quantity remains

unknown. This spot deserves examination. Should the ore be abundant, its value would be enhanced by its proximity to another deposit of ore on Stony Creek, with which it might be worked. A furnace is much wanted in this part of the country, where charcoal and water-power are both plenty.

The ore just referred to on Stony Creek is at the "Silver Diggings," about 2 miles above the mouth of Wells' Creek. Here a shaft 28 feet deep was found, which passed through two bands of ore, the lowest of which, lying lower than the bed of the creek, cannot be worked. The upper, though a small seam, consists of very pure ore. This is of insufficient thickness by itself, but at the upper edge of the shaft there is another layer of ball ore, apparently of ample size, possessing an aggregate thickness of ore equal, we think, to 1 foot.

Along the turnpike W. of Somerset village the following section was made, which only approximates to the truth. It begins at a point 2¼ miles E. of Laurel Hill Creek on the top of a steep hill, where the exposures are—

Shale, 6 feet; Hard grey Sandstone, passing into shale (affording a good example of the facility with which this change seems to have occurred in the original deposition of all these argillo-silicious rocks), 7 feet; Black Slate, 6 inches; Variegated Shales, 10 + feet. To the Eastward are seen (how far beneath the last-mentioned strata is uncertain, but not 100 feet) contorted sandstone, 40 + feet; and Shale, 15 + feet. *Coal terrace;* Shales, 50 feet. *Coal terrace;* thinly-bedded Sandstone, 60 feet; Red and variegated Shales, 30 feet. These are within 2 miles of Somerset. All these rocks dip scarcely 2° towards the N.W.

At Laurel Hill Creek, near Milford, the following section (see Fig. 559) was obtained:—

Shale, olive and blue, hill-top, 18 feet. *Coal,* slaty and poor, 1½ feet; Olive Shale, with a little red shale, 15 feet; Sandstone, easily traced, 20 feet. *Coal,* thickness unknown; Red and variegated Shales, 25 feet; Olive and blue Shales, 25 feet. *Coal,* thickness unknown; Sandstone, 8 feet; Shales and Sandstone, 20 feet.

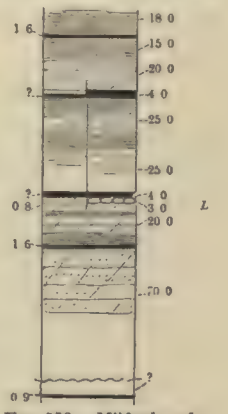


FIG. 559.—Milford and Ben's Creek.

The uppermost coal is seen terracing the hill above Mr Hershberger's sugar camp; the third bed (descending) is seen at his spring house, and ranges high up in Mr Scott's fields; the fourth coal was opened, 1½ feet thick, at Mr Scott's house.

A coal-bed, probably higher than any in this vicinity, is seen at Mr Taylor's spring, near his dwelling, 1 mile from Milford, and ranges away in a terrace W. of his house. One of the most beautiful instances of the regularity with which the soft coal and accompanying black shales, and still softer fire-clays, are denuded along these horizontal outcrops, while the harder rocks above them form a steep slope, and the harder rocks below a gently-sloping terrace in front, may be viewed upon the road to Centreville, about 1 mile from Milford, perfectly well defined, and extending with surprising symmetry for a great distance.

On Ben's Creek, the second and third coals (Ferriferous and Kittanning coals) are each 4 feet thick, and the Ferriferous Limestone 3 feet, well exposed on the turnpike from Johnstown to Somerset, where, in a few dozen yards, it becomes a stratum of workable carbonate of iron. The Kittanning Coal appears for a fourth of a mile along the turnpike leading to Ligonier, the grading of the road conforming itself to the dip.

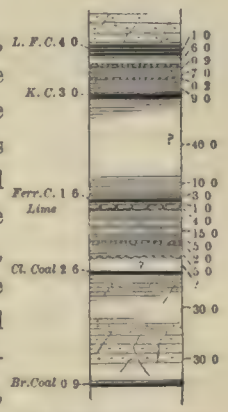


FIG. 560.—Laurel Hill Creek.

Along Roaring Run, from its mouth to the bridge on the Jennerville Road, a sandstone, the upper member of the Seral conglomerate, fills the bed of the stream. A small exposure occurs at Griffith's mill, near the road. Descending the road from the N. to the bridge, we cross the outcrop of a coal-seam, which was ascertained to be the Clarion Coal. It is mined 2 miles N.E. of the mill, where it yields 3 feet of rather indifferent coal. Slate and shale occur above it through a thickness of 50 feet. Covering the surface of these slates we found much iron ore of excellent quality. In the hill W. of this a massive sandstone, 25 feet thick, overlies these rocks. This, following it still W. towards the middle of the basin, seems to change in character, and we are therefore deprived of any key it could afford us to the overlying coal-beds. The facts collected go to show that the Kittanning Coal-bed, 4½ feet thick, opened 2 miles W. of the bridge, and a band of limestone 3 feet thick, underlying it, range extensively through the basin, their outcrop appearing along the streams. Above these we meet with indications of several other coal-seams, the exact

number and thickness of which could not be ascertained. At the mouth of Lick Run, on Ben's Creek, there is a limestone, 5 feet thick, apparently in this part of the series.

The following section (see Fig. 560) was obtained at Husband's mill, on Laurel Hill Creek :—

Lower Freeport Coal, 2 feet ; Slate, 2 inches ; *Coal*, 6 inches ; Fire-clay, 1 foot ; *Coal*, 18 inches ; Fire-clay, 2 feet ; Calcareous Sandstone, 6 feet. *Iron Ore*, in large nodules, closely packed, 9 inches ; Slaty Sandstone, 7 feet. *Iron Ore* (good), 2 inches ; Sandstone, 2 feet ; Fire-clay, 1 foot ; Blue Shale, 6 feet. *Kittanning Coal* (good) 3 feet ; Strata unknown, 40 (?) feet ; Blue Shale, 10 feet ; Black Slate, 3 feet. *Ferriferous Coal*, 1½ feet ; Fire-clay, 12 inches ; Ferriferous Limestone, 4 feet ; Slaty Sandstone, 15 feet ; Shale, with balls of *Iron Ore*, of variable quantity (but amounting sometimes to 2 feet), 5 feet ; Shale, 5 feet to water-level.

Castleman's River, at Shaf's Bridge, flows in the Seral conglomerate, the lowest coal-bed ranging at a height of 100 feet above the water, and it continues to flow in it as far as Snyder's, the dip being 5° to the N.W. The coal enters the water half a mile below, and was once opened upon the left bank, and was 22 inches thick.—(See Fig. 561.)

The Ferriferous Coal-bed descends close to the water at the double bend, a mile and a half below, but rises again as the rapidly-falling stream returns upon and recrosses the lower strata, causing the first coal-bed to re-emerge below the coal-bank, near the forge at Took's Run.

Below this, flowing in the Seral conglomerate, the stream has its bed full of huge masses of fine-grained homogeneous conglomerate, fragments of that formation. Even the Umbral red shales must appear in the little run which enters at the head of the sharp bend.

At McMullin's the first coal-bed appears again in the bed of the stream at two points—one about three-fourths of a mile above the mill, and another a mile below it, as seen on the right bank ; it again appears in the bend at Mr McClintock's spring. The river flows in the conglomerate to its mouth.

Fig. 561.—Castleman's River.

Section near Shaf's Bridge :—

This begins above with fine-grained sandstone, and contains balls of poor ore, 35 feet, lower part shale. *Coal*, 18 inches, exposed—it has a slate roof. Massive Sandstone, 70 feet—rests on the *Lowest Coal*, 22 inches, opened on the stream : it is of good quality. Fire-clay, a few inches ; then Sandstone and conglomerate to the river-bed, 90 feet.

At the head of this section we observed a *coal (?) terrace.* Along the right bank, below the mouth of Scrubglade Run, the sandstone and conglomerate rocks are so arranged, in more and less durable alternations, as to present remarkable overhanging cliffs worn by the yearly freshets which rush down the river-bed in early spring. The annexed sketch represents such a cliff, one layer of which overhangs the river 12 feet.—(See Fig. 562.)

Fig. 562.—Castleman's River and Conglomerate Cliffs (in partial section).

The section at Snyder's is continued towards the top by observations upon the road to the Forge. Mr Weimar's Coal is the third ascending in the series at Snyder's, and the bed in Weimar's orchard is not observed in Mr Snyder's fields.

Freeport Limestone ; fragments found below the variegated shales, with fire-clay and balls of impure carbonate of iron ; the interval not ascertained. *Lower Freeport Coal ;* massive Freeport Sandstone, sometimes conglomeritic, everywhere traceable by the enormous quantity of debris which it has cast down upon all the slopes of Castleman's River and Laurel Hill Creek, 40 feet thick. *Kittanning Coal*, 2½ feet thick ; fine-grained sandstone, containing coarse silicious nodular carbonate of iron, 30 feet. *Ferriferous Coal*, in a terrace 70 feet above the *Clarion Coal*, 18 inches ; this is in a terrace 40 feet above the river-level. This coal has been stripped along the left bank below Snyder's. The Ferriferous Limestone here appears 70 feet

above the river, with 20 feet of slates. It occurs at about the same height on the opposite side at Mr Phillips's.

One mile below Mr Snyder's are seen the following rocks in a little stream :—

Massive conglomeritic sandstone (Freeport Sandstone), 30 + feet. *Kittanning Coal;* interval not measured; then sandstone and shales, 10 feet; black slate, 4 feet; ferruginous slate, 1 foot. *Ferriferous Coal,* said to be 2 feet. Interval, 8 or 10 feet. *Ferriferous Limestone,* 3 feet exposed.

At Squire Connelly's are seen the following rocks :—

Shales, &c., 30 feet. *Coal* (Elk Lick), at Mr King's house, with 80 feet of interval unknown; shale, 15 feet. *Lower Freeport Coal,* 20 inches, poor; fire-clay, sandy, 6 feet; massive sandstone, 15 feet; interval, including 20 feet of compact shale, 70 feet; blue shale, 5 feet. *Ferriferous Coal,* 2 feet; black slate, 8 inches; coal, 4 inches; black slate, 12 inches; *coal,* 18 inches, poor; fire-clay, 12 inches. *Ferriferous Limestone,* 8 feet; olive shale, 15 feet, containing good nodular iron-ore in bands amounting to 6 inches total thickness; a peculiar-looking grey-streaked sandstone, 7 feet. *Coal* (?) 4 inches; black slate and shale, with much good nodular iron-ore, 5 feet.

The same rocks are exposed by Spring Run as follows :—

Black slate, 8 feet. *Coal* (?); interval unknown, 6 feet; sandstone, 12 feet; interval, 15 feet; olive ferriferous shale, 15 feet; black slate, 3 feet. *Upper Freeport* (?) *Coal;* Sandstone, 1 foot. *Freeport* (?) *Limestone,* 2 feet; sandstone, 60 feet; shale, 7 feet; grey sandstone, 2 feet; olive ferriferous shales, 9 feet; ferriferous sandstone, 6 feet; black slate, 12 feet. *Ferriferous Coal,* 4 inches; blue shale, 2 feet; *Coal,* 11 inches. *Ferriferous Limestone,* 8 feet; sandstone, 1 foot; shale, 1 foot; sandstone, 6 feet.

At Mr McMullin's the following section was obtained :—

The hills here exceed 500 feet in height. At the top are shales, &c., 35 feet. *Coal;* Shales, &c., 100 feet. *Coal terrace* on a level with the summit of the Fort Hill opposite, and displaying 10 feet of shales, some of which are red. Below are thinly-bedded sandstones and shales, 80 feet. *Coal,* the smut seen at McMullin's barn; sandstone exposed in the road, 20 feet; strata undetermined 30 feet. *Lower Freeport Coal;* soft black slate of roof, 2 feet; slaty sandstone, 30 feet. *Kittanning Coal;* floor, 2 feet of black slate; sandstone, 10 feet; unknown, 50 feet. *Ferriferous Coal;* limestone not exposed; massive conglomeritic sandstone fragments, 50 feet; flaggy sandstone, 6 feet; black slate, 1½ feet; sandstone, 1½ feet; black slate, 4 feet; sandstone, single stratum, 3 to 6 feet thick; immediately over the *Clarion Coal,* which is hard and poor, 1½ feet, including 4 inches of slate; slate, 2 feet; *Coal,* hard, 1 foot; slate, 1 foot; *fossiliferous* obliquely-bedded sandstone, 25 feet.

Here occurs an instance of ancient denudation, producing hollows in the surface of a bed of black slate upon and in which coal was afterwards deposited.—(See Fig. 563.)

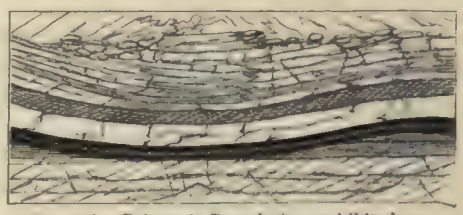


Fig. 563.—Palæozoic Denudation, exhibited on Castleman's River.

A little farther down the river, the same bed appears half out of the water, and only 1 foot thick, roofed by a massive stratum of sandstone, 20 feet thick. The coal is here more slaty, and the sandstone lies immediately upon it, forming, where the coal goes under water-level, a gigantic tessellated pavement for the river, from which rise cliffs upon each shore of thinly-bedded sandstone, the bases of the lofty wooded walls that support the cultivated upland. This pavement is covered by angular fragments of Seral conglomerate, a single one of which will sometimes contain 2000 cubic feet of stone.

At the Turkey Foot, stalactites are seen upon the left bank, pendant from the rocks below the Ferriferous Limestone bed.

On Drake's Run a band of iron ore, 9 inches thick, occurs above the Kittanning Coal, which is 3 feet thick. The same bed of ore is seen at Whipley's on the Clay Turnpike, at the foot of Laurel Hill, and again on Gabriel's Run, S. of the Youghiogheny.

On the Youghiogheny River, 1 mile above Smythfield, a large bed of coal is opened, exhibiting:—Black slate; *Coal*, 15 inches; slate, 1½ inches; *Coal*, 15 inches; fire-clay, 18 inches; *Coal*, 20 inches; slate, 1 inch; *Coal*, 4 inches (in all 4½ feet of coal, enclosing 20 inches of fire-clay and slate); slate, 2 feet; then limestone, of a thickness unknown.

Fifty feet above this coal-bed is seen a slaty limestone, from 2 to 3 feet thick, supporting 3 feet of green shale, and above it massive sandstone.

SECOND BASIN.

On Black Lick Creek, 10 miles W. of Ebensburg, near Lewis and Rodgers' sawmill, the following strata are exposed:—*Coal*, 4 feet (2 inches parting-slate, 18 inches from the floor); fire-clay; some ore. Strata having a thickness of 100 feet bring us to another *Coal-bed*, 3 feet thick; and 50 feet higher, a third *Coal-bed*, 18 inches thick (supposed to be the same as at the hill, half a mile to the W.) A fourth *Coal*, 18 inches thick, lies 30 feet above the last.

On the Old State Road, 7 miles from Indiana, and 2 miles S. of the Clay Turnpike, there is a *Coal-bed*, 4 feet thick, in which, 1 foot from the floor, is a seam of slate, 1 inch thick; roof, black slate.

Four miles S. of the Cherry Tree is a coal-bed, 3 or 4 feet thick; slate roof.

Four miles E. of Indiana are coal and limestone; the former 4 feet thick, and 5 feet above the latter.

One and a half miles W. of Strongtown, on the E. side of Yellow Creek, the same bed appears, 3½ feet thick, with 2 inches of slate, 1 foot from the floor; roof, sandstone.

Limestone lies in the turnpike road, 70 feet above the coal-bed.

Limestone, 5 feet thick, is exposed 2 miles S.W. of Strongtown, the upper part slaty. Thirty feet above it is a quarry of blue micaceous sandstone, used for tombstones and grindstones.

Coal, 3 feet thick, is mined 3 miles S. of this spot; 30 feet above the coal is limestone, and under it lie 3 feet of highly ferriferous slate.

East of *Armagh* are seen indications of a series of seven beds; the Lower Freeport Coal, measuring 6 feet at the foot of the mountain, 1½ miles N. of the turnpike gate, and the Brookville Coal, 3 feet, on Finley's Run. Almost immediately beneath it are seen the sandstones of the Seral conglomerate, 50 feet thick, and farther down the stream are seen the Umbral red shales with their ore. It will be recollected that the Lower Freeport Coal is the Great Bed at Punxutawney.

The following strata are exposed half a mile below the Conemaugh furnace, on the Pennsylvania Railroad, on the W. dip of Laurel Hill:—

Argillaceous irregularly-bedded Sandstone, with nests of red shale, from 40 to 60 feet; *Coal*, divided by 2 inches of Slate, 2 feet 6 inches; Sandy Shale and coarse Stigmaria clay, 7 to 10 feet; Light-grey fine irregularly-bedded Sandstone, with shale partings, 55 to 60 feet; Argillaceous Shales, 15 to 20 feet; *Coal*, 1 (?) foot; Fire-clay, 3 feet; Coal, Shales, and thin flaggy Sandstone, 15 feet; Seral conglomerate Sandstone, lower bed somewhat pebbly, 40 + feet.

The coal worked for Conemaugh furnace, on the W. side of Laurel Hill Gap, supposed to be next to the lowest, has the following dimensions:—

Coal, rather dirty, though good, from 3 feet 6 inches to 3 feet 9 inches; Fire-clay, Shale, Stigmaria, 4 inches; *Coal*, 6 inches.

The bed is very closely fissured with vertical cleavage running nearly up and down the dip.

When this coal is purest, and is carefully coked, 100 bushels yield 130 bushels of good coke, weighing from 40 to 60 lb. to the bushel. It is coked in long heaps containing 2000 bushels. When the coal is coarse and good, from four to six days are required in coking. When fine coal is used, from eight to sixteen days are necessary.

From the cuttings of the Pennsylvania Railroad at and E. of Lockport, the following section (Fig. 564) was compiled; the strata dip gently Eastward:—

Sandy Shale, ore balls in lower part. Dark-blue slate; Olive Shale, containing ore nodules. Limestone, ferriferous; Micaceous blue Sandstone. *Coal*, 8 inches; Fire-clay, ball ore, and Sandstone, 60 + feet. *Coal*, 5 to 6 feet, in three benches. *Silicious Limestone*, impure, 3 feet; Blue Slate, 4 feet. *Limestone*, thin bands in 10 feet; Fire-clay, indurated, 8 feet; Blue Slate, 15 feet. *Coal*, 2 to 3 feet 6 inches. *Limestone*, rotten, ferruginous, 10 feet; Black Slate, 1 foot. Fire-clay, containing ore balls, 20 feet; Interval, 20 feet; Sandy Slate, 15 feet. *Coal*, 22 inches; Slate, 5 feet. *Blue Limestone*, 2 to 3 feet; Hydraulic Cement and iron ore, 7 inches; Olive and blue Shale, with scattered balls, 12 to 20 feet; Iron ore, 5 inches; Shale, 25 + feet. *Coal*, 6 inches; Slate, 1 foot; *Coal*, 2 feet 4 inches; Slate and Sandstone.

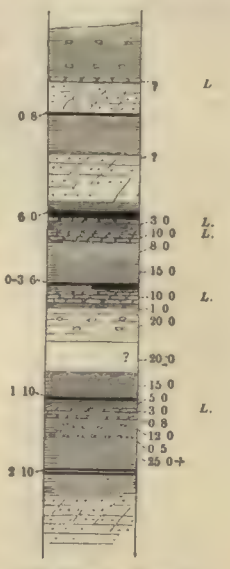


Fig. 564.—Lockport.

At *Centreville*, near the centre of the basin, only the upper coal and limestone are out of the water. The coal, 6 feet thick, emerges half a mile above and 1½ miles below the village; but continuing to ascend the river, all the beds of the foregoing section rise from the river-bed.

Two coal-beds, probably of the Barren series, appear in the hills. Two miles N. of Bolivar, the third coal from the top, or the Kittanning Coal, measures 4 feet. The 4-feet bed of coal, 5 miles W. of Ebensburg, and again 7 miles W. of Ebensburg, based on ferruginous sandstone, exhibiting vegetable impressions,—the former being within half a mile of an exposure of limestone near the Black Lick Creek,—bears doubtless a relation to this part of the general series.

From the vicinity of Fairfield to a little N. of Ligonier there is a belt of country along the middle of the basin, from 2 to 3 miles wide, which embraces the upper strata, the most productive in coal and limestone of any in the valley. The limestone is here more abundant than usual. The following section represents the stratification about 2 miles N. of Ligonier:—

Highest land; Coal (?) bench; Interval, 10 feet. Limestone, tolerably good, 7 or 8 feet; Fine-bedded Sandstone, 35 feet. *Sewickly Coal*, opened 3 feet; Interval, 5 (?) feet. *Limestone*, 8 feet, good, hard, and blue. This is 6 feet at Kieffer's, and elsewhere 4 feet; Shales and black Slates, 10 feet. *Redstone Coal*, 3 feet; Shales, brown and black Slate, 20 feet. *Pittsburg Coal*, 8 feet 3 inches (at Kieffer's, 10 feet; at Giesy's, 7 feet); Interval, 20 feet. *Pittsburg Limestone*, white, flaggy, good, from 4 to 9 feet; Flaggy Sandstone, &c., 20 feet. *Coal*, 3 feet, good; Interval, 8 feet. *Limestone, ferruginous*, 3 feet; Shales, olive and black, 15 (?) feet. *Coal*, only the outcrop visible; Sandstone (Mahoning), 50 feet; Olive Shales, 24 feet; Black Slate, 6 feet. *Elk-Lick Coal*, outcrop only; Interval, 15 feet. *Coal*, outcrop; Olive Ferriferous Shale, 30 feet. *Upper Freeport Coal*, 1 foot. Freeport Limestone, 1 foot.

This section, representing the upper group of coal, taken in connection with that at Lockport exhibiting the lower, furnishes a very complete representation of the whole series of beds composing this coal-basin. In the Ligonier neighbourhood other lower bands were noted, which I have not included in the section, as they did not admit of precise measurements. One of these is a coal-seam, 1 foot thick, corresponding probably to the Kittanning Coal-bed of other localities; another is a coal-seam, the representative of the Brookville Coal, near the foot of Chestnut Ridge, where it is 5½ feet thick. At a short distance beneath this appear the Seral sandstones. Both of these coals, with their accompanying rocks, are far below the water-level in the immediate neighbourhood of Ligonier town, and emerge to the day only on the two sides of the basin.

The large Pittsburg Coal occurs on many farms along the central part of the valley, having its E. and W. outcrops along the slopes of a range of high narrow hills occupying the middle of the trough. It varies in thickness from 7 to 10 feet. The coal is jet black, of a brilliant lustre, and comparatively free from sulphuret of iron and from slate.

It is of a firm texture, though it affects, to a partial extent, that columnar form so prevalent in many of the coal-beds in the basins near the Alleghany Mountain. At Giesy's it is lifted in long columnar pieces, but at Kieffer's and other places it does not show this structure.

The Brookville Coal, worked near the foot of Chestnut Ridge, after dipping under the valley, emerged on the other side of it, between Laughlintown and Laurel Hill, where its outcrop is indicated by a smut immediately above the upper beds of the Seral conglomerate. It is there overlaid by several other seams occupying the position of the lower beds seen in our previous sections. Thus above it the Ferriferous Coal-bed ; 1½ feet thick, is seen, accompanied by a limestone. Next in the order ascending are two thin adjacent bands, the representatives probably of the Kittanning Coal, while higher up occurs a bed, which is here 3 feet thick, and accompanied by a considerable amount of iron ore.

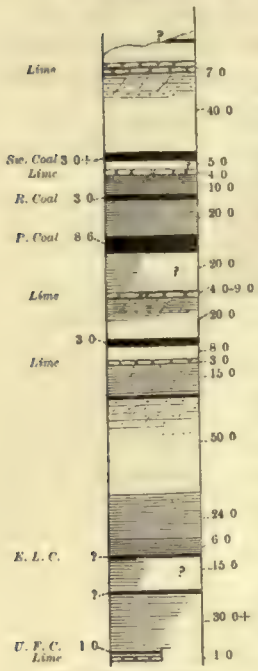


Fig. 565.—Ligonier.

At Ross furnace, in the same belt of strata, but farther to the N. by 6 miles, the Brookville Coal-bed was opened by us, and ascertained to be 4½ feet thick, though it had lain neglected, under an erroneous belief that it was of very insignificant size. A knowledge of the stratification led to the apprehension that some error had been committed in the original opening of the bed, and the result of a re-examination furnished a striking illustration of the value of systematic investigation even in a country the resources of which may be supposed to be already developed.

A carefully-compiled section, elaborately made from observations in a great variety of places, shows that the only valuable material included within the first or uppermost 150 feet of strata in the central hills of the valley, is a single band of limestone, about 1½ feet thick, while the only workable coal-seam within the space is a high bed, probably the first beneath the Pittsburg Coal, near the top of a hill in the very middle of the basin. Below this barren group of rocks, but only at the sides of the valley, occur the lower coal-seams and a limestone. Thus the Upper Freeport Coal-bed shows itself along the valley of Four-mile Run, and a little farther W., immediately at the base of Chestnut Ridge. It is opened at the bridge over the stream, on the Greensburg Road, a mile W. of Four-mile Run, where it is 3 feet 1 inch thick. This bed corresponds in position with that opened 6 miles S.S.W. from Ligonier, though the latter bed is only 1 foot 1 inch in thickness. So remarkable a declension in the size of the bed in so short a distance in this direction, is the only circumstance which suggests any doubt in respect to the identity of the coal of the two places. A band of limestone accompanies the coal at each locality. Indications of a large bed of coarse calcareous iron-ore occur in immediate connection with the limestone at the place mentioned on the Greensburg Road.

On Chestnut Ridge, near an old furnace on Jacob's Creek, 3 miles S.W. of Harman's, the same coal-bed has been opened, and shows a thickness exceeding 4 feet. A band of cannel coal, 6 inches thick, traverses the seam about 18 inches from the roof both here and at the opening just previously mentioned, serving, if other evidence were wanting, to identify the bed. Its underlying limestone and attendant iron-ore were also found within 4 or 6 feet of the coal. The limestone measured 1 foot, and the kidney ore over it amounted to from 2 to 5 inches in total thickness.

The Kittanning Coal is separated by about 40 feet of sandstone from the Upper Freeport Coal, and by 35 feet of shale from the Ferriferous Coal, which is here, like the Kittanning Coal, 2 feet thick. The separating shales contain a solid band of iron ore of excellent quality, varying in thickness from 5 to 8 inches, besides a considerable amount of ore in detached flattened balls. These things occur at Harman's, up Four-mile Run, above the mill which is at the crossing of the Greensburg Road. The spot appears to be important on account of the abundance and good quality of the ore, though the immediately adjoining coal-beds are scarcely of sufficient thickness to be available for the manufacture of iron at this place, the thicker workable Upper Freeport Coal, with its companion, the limestone, lying higher up in the same hill. A heavy bed of conglomerate underlies the Ferriferous Coal and Limestone.

The following section was made upon Four-mile Run, 5 miles above its mouth, constructed upon the hypothesis that Mr Nelson's coal-bed is the same found upon the road leading from the mill to Greensburg.

Top of Hill, 30 feet ; Coal (?) terrace ; Shales, 10 feet. Limestone of Barren Measures, 1½ feet ; Interval, 8

feet. *Coal Smut*, 6 inches; Roof and floor, grey-streaked Sandstone (this is probably the coal swept away from the summit of the hill at the head of the other section, leaving it flat, and sloping at an angle of 7° to the E.S.E.) Sandstone, &c., 50 feet. Coal Smut; Interval, 30 feet; Black Slate, 8+ feet (containing 1 inch of coal, and underlaid by an argillaceous conglomerate, hard when dug, but soft on exposure); Shales, 6+ feet. *Nelson's Coal*, 13 inches; Yellow Clay; Interval, 4 to 10 feet. *Limestone.*

Another section, made at Mr Nelson's, 4 miles distant from that now given, reads thus:—

Olive Shale, 20 feet. Black Slate, 15 feet. *Coal* (?); Interval, 10 feet. *Coal* (?); Interval, 20 feet. Olive Shales, 10 feet. Fire-clay, 6 inches. *Coal*, 3 feet 1 inch. Fire-clay, 3 feet; Interval, 8 feet. Limestone (?) (continued at Mr Herman's, on Four-mile Run), conglomeritic Sandstone, 20 feet exposed, perhaps 50 feet in all; Shales, 30 feet; Black Slate, 10 feet. *Coal*, said to be 2 feet; Black Slate, 7 feet. Shales, very ferriferous, 14 feet, containing perhaps 1½ feet of ore; Iron ore, black carbonate, 5 to 8 inches thick; Shale, compact, 3½ feet; Sandstone, Shale, &c., 8+ feet. *Coal*, 2 feet, good at water-level. Seral conglomerate.

Eastward from the old furnace of Jacob's Creek occur the Ferriferous and Kittanning coal-beds, with their interposed iron-ore. Here they are only 20 feet apart, and show a corresponding reduction of thickness, the Ferriferous Coal-bed measuring but 1 foot, and the Kittanning Bed, 1½ feet. In the interval we find 6 inches of good iron-ore embraced within 4 feet of shale.

Near the above spot the red Umbral shale shows its limestone cropping out in a stratum 15 feet in thickness. The iron ore near the top of the formation was formerly procured for the furnace. It lies in several bands, whose aggregate thickness is about 8 inches.

The topographical features of the part of the basin we have been describing are somewhat peculiar, owing to the prevalence of soft shales in that portion of the series occupied by the hills of the central belt of the valley. The summits are often quite plain, though gently sloping in conformity with the gentle dip of the strata.

South as well as North of the Somerset and Mount Pleasant Road, the Barren Measures fill the middle of the basin.

The Upper Freeport Coal and its limestone certainly exist at the base of the hills, and perhaps the next inferior Lower Freeport Coal. These are the only available strata in all the central region at the head-waters of Indian Creek.

Passing Southward down the tributaries of Indian Creek, we follow this stream for 8 or 10 miles through the Coal-measures, descending in the stratification until we reach Fayette furnace at the mouth of Laurel Run, where the stream flows over rocks that may be referred either to the upper part of the Seral conglomerate, or the lower portion of the Coal-measures; for the Brookville Coal (here 100 feet beneath the creek) may be assigned as well to the former as to the latter. Continuing down the creek, which enters lower and lower strata in its course, the underlying Brookville (?) Coal-bed at length appears about 2 miles below St John's furnace, where it is embraced among massive sandstones, which form a series of steps at their outcrop along the channel of the creek nearly the whole way from a mile above the furnace to the mouth of the stream. We may consider the main body of Seral conglomerate to commence below the coal-bed, and to embrace all the rocks thence to near the mouth of the creek, where the stream at last reaches the Umbral red shales, exposing them in a thickness of 50 feet resting upon their well-marked calcareous sandstone at the water-level. As the rocks here dip gently E. towards the middle of the basin, we find these Umbral beds disappearing below the Youghiogheny as we ascend it in the same direction, the neighbouring bluffs showing all the way at their base vast bodies of debris in the form of broken blocks of sandstone and conglomerate, derived from the cliffs above, where the Seral conglomerate rises nearly perpendicularly 200 feet from the stream. Regarding the Seral conglomerate as terminating at the first coal-seam, the total thickness of the formation will be about 150 feet; but if we make it to embrace the coal and the over-resting conglomerate and sandstone, the whole will measure about 250 feet. Ascending the river, the Umbral shales are out of reach until we get about 2 miles above the Ohiopile Falls, where they emerge with a tolerably steep Western dip, and are followed, as we approach the gap of the mountain, by the Vespertine Sandstones, and finally, at the axis of the ridge, by those of the Vergent series.

The sections designed to exhibit the stratification in this region were unavoidably meagre, though data enough were collected to establish an accordance among themselves, and between them and the corresponding parts of a more complete section obtained in the neighbourhood of Fayette furnace.—(See Fig. 566.)

The largest coal-bed in this part of the valley is the Ferriferous Coal, which, near the furnace, yields 3½ feet of good coal, and an extra foot of an inferior kind. It has also been exposed, at intervals, for several hundred feet, by the erosive action of the stream along Indian Creek just above the mouth of Laurel Run; and was once worked at this place by stripping it at its outcrop. At both of the above localities it underlies a bed of brown shale. The coal may be seen cropping out in a deep ravine to the W. of Indian Creek, crossed by the turnpike leading to Connellsville. It was once mined by stripping at St John's furnace, where its elevation above the stream is about 80 feet.

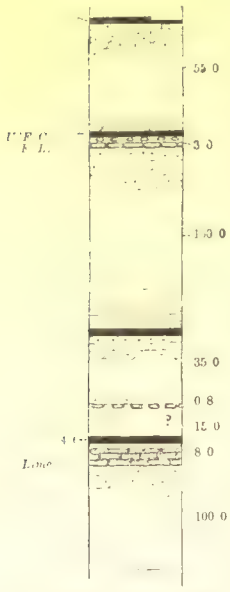


FIG. 566.—Indian Creek.

The limestone accompanying this coal appears where the turnpike crosses Indian Creek, in a bed 8 feet thick. About 15 feet above the coal lies a band of iron ore 8 inches thick.

The coal-seam, previously stated to be 100 feet lower in the series, was passed in boring a salt-well near the furnace. Its thickness in the well has been stated to us at one foot, agreeing with its dimensions at its outcrop in the creek's bed, 2 miles below St John's furnace. This coal is of excellent quality.

Fifty feet above the Ferriferous Coal-bed lies the Kittanning Coal, once opened where the turnpike ascends the first hill W. of Indian Creek, and stated to be 3 feet thick, but of indifferent quality.

About 100 feet above this, a band of light-coloured pure limestone has been quarried, the thickness of which could not be ascertained from the falling in of the earth. A bed of coal overlies it within a few feet, yielding, it is stated, 3 feet of good coal. Strata deemed to be the same were met with 4 miles farther S., where the coal is in two bands, separated by nearly 4 feet of fire-clay, the upper band showing 3 feet of coal containing no impurity but sulphuret of iron, and the lower band 1½ feet of equally good quality. A calcareous spring, indicating the outcrop of the limestone, issues about 15 feet below the outcrop of the coal. About 40 feet above the coal-bed occurs a bench, which suggests the presence of another seam. Being unable to procure any extensive continuous section of the strata in this vicinity, we are in some doubt as to which part of the Coal-measures we are to refer the first-mentioned seam with its limestone, for we may regard it as either the Freeport or the Ferriferous bed of the series. Appearances incline us to refer it to the former.

At Lennard's, one mile N. of Bear Run, appears a band of the Ferriferous Limestone, though the coal itself has not yet been seen here. Fifty feet higher in the hill is an outcrop crossing the road, which appears to belong to a large bed. Westward of Lennard's, towards the river, two lower coal-seams have been opened on a small run; the uppermost being 1½ feet thick, and the undermost, 100 feet farther down, being 2 feet thick. No limestone has yet been recognised accompanying the first of these coals.

To return to the section at Fayette furnace, we find from 50 to 60 feet above the Upper Freeport Coal and its limestone, a well-marked bench, containing probably the highest seam which has resisted the denuding action of the waters in this part of the valley.

On Bear Run, 3 miles N. of the Ohiopile Falls, and one mile from the river by the course of the run, a coal-bed has been opened, yielding 3 feet of very pure coal. It overlies a mass of sandstone, this rock constituting the principal material between this level and that of the river below. It was impossible to decide upon the precise position in the series held by this bed, though everything, except the absence of a band of limestone, suggests its reference to the Ferriferous Coal-seam. It is regarded as the purest coal in this section of the valley. A very irregular coal-seam occurs 30 feet down, between the sandstone: it varies from an inch to a foot in thickness, and probably corresponds with a very irregular bed observed at the Ohiopile Falls, and again on Maiden Creek; at which latter place it rests beneath 20 feet of sandstone, and is 2 feet thick, having the appearance of having been crushed.

Signs of coal occur near the head of Bear Run, where the hills rise to an elevation of nearly 250 feet above the position occupied by the Seral conglomerate. Near their summits we find a coal-smut, indicating a large bed, probably the same with that already noticed as appearing in the road at Lennard's. In the Seral conglomerate occurs here a bed of coal 2 feet thick.

That part of the valley embraced between the Youghiogheny and the S. line of the State has yielded us less satisfactory data for a description of its geology than any district farther North. The season appropriated to it being far advanced, and the country requiring a more leisurely examination to reveal its obscure stratification than we were able to afford, little was accomplished beyond what amounted to a reconnaissance of its topography, and the identification of a few of its beds.

A seam of coal was formerly opened and mined to a small extent on the first stream which enters the river from the W. below Cucumber Run. It is 4 feet and a few inches thick, including 5 inches of slate near the top. Lying on the banks of a stream having little fall, and in a neighbourhood deficient in exposures of the strata, it was impossible to settle its position in the series, though the evidence which would refer it to one of the lower beds preponderates. Did any evidences of limestone accompany it, we should regard it as the Ferriferous Coal; yet this rock being elsewhere sometimes several feet below its coal, it may exist here under the level of the run. Though no other coal-bed has been discovered in this neighbourhood S.W. of the falls, the great height of the hills, and the occurrence of several benches, imply the existence of at least four or five seams in all.

Near the middle of the valley, and half a mile N. of the National Road, coal occurs in the lowest grounds. Fragments of conglomerate abounding near it, induce us to refer it to the Ferriferous Coal-bed. The seam is 3 feet thick, parted in the middle by an inch of slate; it yields a fuel well adapted to the purposes of the blacksmith. It is worked by stripping only. The strata here are level. About 30 feet above this, in an adjoining hill, is seen the smut of another coal-seam (Kittanning Coal ?), which corresponds very well in position with the bed at Smythfield in the basin E. of Laurel Hill. Another bench, showing black coal-slate (Lower Freeport Coal ?), appears 25 feet above this. These three are all the coal-beds thought to exist in this neighbourhood.

A fourth of a mile S. of the National Road, and one mile E. of the former place, a coal-bed (Kittanning Coal ?), corresponding in character with the Smythfield Seam, is worked at its outcrop. The bed contains, first, a layer of coal 2 feet thick, resting on one foot of good fire-clay, and this is underlaid by 15 inches of coal, which also reposes on good fire-clay. The coal, otherwise pure, is somewhat sulphurous. Twenty-five feet above this may be noticed another coal-bench (Lower Freeport Coal ?)

At Chalk Hill on the National Road, not far from Stewart's furnace, there occurs a poor bed of slaty coal, overlaid by a heavy bed of olive shale; it is 1 foot 6 inches thick. A well sunk 50 feet below this coal reached no other bed, nor did it meet the coarse sandstone of the Seral conglomerate, which crops out within less than a mile W. of Chalk Hill, towards Chestnut Ridge, here erroneously called Laurel Hill. Higher up the mountain the calcareous sandstone near the base of the Vespertine series displays itself; it is used as a road stone, for which it is well suited by its toughness.

The lowest seam of coal along the W. margin of the basin might, I conceive, be easily detected by following the indications of the rocks exposed along the National Turnpike. Its discovery here would prove of some utility.

CHAPTER XXX.

OF THE THIN GROUP OF COAL STRATA BETWEEN THE UMBRAL RED SHALE AND THE MAIN SERAL CONGLOMERATE, IN SOMERSET AND FAYETTE COUNTIES.

In describing the strata in the neighbourhood of Turkey Foot, in the basin E. of Laurel Hill, we made mention of a thin group of coal-bearing rocks, having no connection with the main body of the Coal-measures, but holding a position between the upper layers of the Umbral and the lower rocks of the Seral series. These earlier-

formed carboniferous strata, gradually developing themselves in our progress to the S.W., do not show themselves conspicuously in the basin W. of Laurel Hill until we reach the district S. of the Youghiogheny, corresponding to the Turkey Foot country on the opposite side of the mountain. Near Stewart's furnace they contain a seam of excellent coal 4 feet in thickness. It lies entirely below the coarse Seral conglomerate, and 20 feet below the band of iron ore which usually marks the upper limit of the Umbral red shale. The ore occurs in a brown shale, so that it may be considered as appertaining to the Coal-measures, which thus form, as it were, a subordinate part of the Umbral red-shale formation. This ore occurs in four separate bands, two of which, within 3 feet of each other, are near enough to be worked together. The upper band is less than 1 inch in thickness, while the lower varies from 1½ to 3 inches. These were the most productive layers known here, until others a little thicker were discovered in the same formation N. of the National Road, and 4 miles from the furnace. In the newer locality the ore lies in two adjacent layers, equivalent in all to a thickness of about 8 inches; its quality is very good. The same ore, at the top of the red shale, was formerly worked on the Clay Turnpike on Chestnut Ridge near Connellsville, and is said to have proved abundant and good.

Valuable bands of iron ore occupying a similar position have already been exhibited, in a section representing the stratification at the gap of the Cheat River through South Laurel Hill (Chestnut Ridge).

Iron Furnaces.—The following are the iron furnaces W. of the Alleghany Mountain, and E. of Chestnut Ridge, which, in 1854, were engaged in the smelting of iron :—

Four at Johnstown—Cambria Iron Company. One at Johnstown—Ray and Mathews. One, Conemaugh Furnace, in Laurel Hill Gap—Ray and Mathews. One, Indiana Furnace, ½ mile N. of Canal—Baker. Two on Black Lick Creek, 3 miles N. of Canal—Buena Vista Furnace and Cambria Iron Companies. One, Cambria Furnace, 3½ miles N.W. of Johnstown—Cambria Iron Company. Two, 3 miles S. of Johnstown, on Mill and Ben's creeks—Cambria Iron Company. One, Laurel Hill Furnace, 6 miles S.W. of Conemaugh—Royer and McAllister. One, Hall and Company's Furnace, 10 miles S. of last. Two, Hall and Company's, and Mathial and Company's, 10 miles farther S. One, Shade Furnace, 16 miles S.E. of Johnstown.

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The geology of Pennsylvania; a government survey, by Henry Darwin Rogers, state geologist ... Philadelphia, J. B. Lippincott & co., 1858.

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